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THE MOVEMENTS OF A GIANT SUN.

BY RICHARD A. PROCTOR.

IT may be remembered perhaps that when as yet (in the northern hemisphere at least) the great comet of 1882 had only been seen in the full glory of sunlight, and nothing of its real course was known, M. Thollon at Nice from a single spectroscopic observation was able to announce that the comet was receding from us. Nothing more promising perhaps was ever done by the spectroscopic method of determining movements of recession and approach. It had but recently been discovered that some comets show the lines of sodium as well as the broad carbon bands (useless for the method in question) and these lines in the spectrum of the great comet of 1882 had been visible but a short time, and were studied by Thollon but a few minutes. Yet in those few minutes he had been able to detect what seems at the first view hopelessly out of the range of spectroscopic work, the fact that the comet's distance was increasing.

It seems likely that the scientific world will soon hear a good deal of this promising but most difficult line of research. The great star which was the first to respond to the spectroscopic method of measuring motion is beginning to give information of a new and most unexpected character, associated with other strange information which it had given in response to inquiries of another sort.

The giant star Sirius belongs to a class of suns differing in very marked manner from our own. He is so much larger judged by the quantity of light which he emits, that for that reason alone we should place him in another class, just as we separate the giant planets from the earth and Mars, Venus, and Mercury on the one hand, and from orbs like our sun on the other. Although the average of the best measurements (or rather attempts to measure) of his distance sets him at least fifteen years' light journey from us, he shines much more brightly than any star in the heavens, and, according to the photometric observations of Zöllner, about 200 times as brightly as our sun would shine if set beside him. This, assuming the surfaces to be of equal intrinsic lustre would imply a surface 200 times as great, a diameter about 14 times as great and a volume nearly 3,000 times as great as our sun's. But the spectrum of Sirius gives reason for believing that his intrinsic lustre is considerably greater than the sun's, so that we may largely diminish this estimate of his volume. Still we cannot assign to Sirius much less than 1,000 times the volume of the sun; and probably his mass exceeds the sun's in not much less degree. I have just mentioned the spectroscopic evidence as to the quality of his light. Along with about 300 stars out of 600 observed by Secchi he shows a spectrum remarkable for the great strength of the hydrogen lines; and the assumptions seem permissible that all the stars showing this spectrum belong to a higher class (in regard to size and mass) than our sun, that they are younger suns, and glowing with more intense lustre.

When the spectroscopic method of measuring movements of approach and recession was first suggested it naturally occurred to spectroscopists to apply it to this most splendid star. The method itself may be readily indicated though not quite so readily explained. It is particularly interesting to myself, because it was reading an early adumbration (so to speak) of the actual method, by M. Döppler, which first moved me to commit my thoughts on any scientific subject to paper,—as the printed pages of the *Cornhill* (for December 1863) are "alive this day to testify." I may also mention, with perhaps pardonable pleasure, that I chanced to be the first who publicly enunciated the actual method by which alone successful results can be obtained; albeit this was so clear and obvious a deduction from Döppler's imperfect but pregnant reasoning that it must have occurred to several even earlier, and when I wrote was actually being tested by Huggins and Secchi.

The principle may be thus presented—

Light travels at the rate of some 186,000 miles a second, being propagated (we know not how) in a series of undulations, the broadest waves giving red light, the narrowest giving violet light, the breadths ranging from these extremes through those belonging to the colours red, orange, yellow, green, blue, indigo, and violet. White light is produced by the combination of all these waves just as noise is produced by the combination of multitudinous sound tones. Now when we cross a series of undulations in water, meeting them as they travel onwards, more pass us in any given time than when we are at rest, while if we move the same way so that they overtake us, fewer pass us in a given time. Judging by the number so passing and their known rate of motion, the inference would be (were we unconscious of our own movement) that they were narrower in the former case and broader in the latter than they really are. Apply this reasoning to sound-waves and it will be seen that if we are approaching a source of sound the sound waves should seem narrower, that is the tone higher, while if we are receding from the source of sound the sound waves should seem broader or the tone deeper. Experiment has shown this to be so, the change of tone being found to correspond precisely with that shown by calculation to be due to the measured rate of motion towards or from the source of sound. A rough observation of the change of tone can often be made during railway travelling, especially in America where, besides steam-whistles, bells are used. For it will be found that the tone of the whistle or bell of a passing engine lowers markedly at the moment when in passing the whistle or bell ceases to approach and begins to recede.

Now as light travels in a series of waves it is manifest that the same law must apply to light as to sound. If we are approaching a source of light of one definite tint the light waves will be shortened and therefore the

tint changed in the direction from red towards violet in the spectrum. If we are receding from such a source of light there would be a similar change, but in the opposite direction,—that is from whatever the tint might be to a tint somewhat nearer the red end of the spectrum. All that would be necessary in such a case would be that the velocity of approach or recession should be comparable with the velocity of light, or 186,000 miles per second.

Döppler's idea was that movements of recession or approach among the stars might be indicated in this way, the stars of ruddier tints being those which were receding from us, and those of bluer tints being those which were approaching. He overlooked the circumstance that the stars do not shine with definite tints, but with white light, that is with all the colours of the rainbow combined. It would be as impossible to judge by the sound-wave test of the approach or recession of something moving with noisy clatter, as to determine by the colour-test whether a star is approaching or receding. But if among the sounds producing a noisy clatter were only one whose tone was distinct and known, we might, despite the noise, determine the question of approach or recession. So, if we can select even among the multitudinous tints forming the light of a star a single tint which we know, that tint will tell us of the star's approach or recession, if only the rate of such motion is great enough to cause measurable displacement of the known tint towards either the red or the violet end of the spectrum. Now in the spectrum of Sirius, as already mentioned, the lines of hydrogen are very strong; they are quite unmistakable also *as* the lines of hydrogen, so that the astronomer can compare any given line of hydrogen—say the one in the red part of the spectrum—with the corresponding line of hydrogen as given by the glowing gas in one of his tubes.

The comparison so made by Dr. W. Huggins, the most skilful of our English spectroscopists showed that Sirius was receding from the earth at the rate of more than twenty miles an hour. Later observations at our chief national observatory confirmed his results.

So far only what was originally likely enough had been recognised. The observation, like others applied to the stars, showed a more rapid rate of motion among the stars than many astronomers had supposed to exist. In particular the theory of M. Otto Struve that stellar motions average between three and four miles per second was roughly shaken. But I had already shown from other considerations that Otto Struve was probably mistaken.

But of late years the evidence obtained at Greenwich has tended to show that the motion of Sirius is diminishing. And now it is found that the motion of recession has become so slow that we may expect it presently to change into a motion of approach,—which may probably increase, reach its maximum, then diminish, change into a motion of recession, and so forth, as though Sirius were travelling in a mighty orbit with movements alternately carrying him towards and from our sun.

Now Peters and Auwers long since showed that the thwart motion of Sirius (that is the star's apparent motion on the vault of heaven) is affected by a peculiarity indicating orbital motion. Mr. Alvan Clarke, the celebrated optician of Cambridge, Mass., discovered a companion of Sirius which has been regarded as probably the cause of the motion of Sirius,—*not* the centre round which Sirius is travelling, but the cause of the motion of Sirius around the point which is their common centre of gravity. The orbit estimated from either star as a centre has a diameter not less than 100 times greater than the orbit of the earth round the sun, yet (so great is the combined mass of the two stars) the period of circuit is less than half a century. Supposing the mass of Sirius to be ten times greater than the mass of the faint companion, the orbit of Sirius around the common centre of gravity would have a diameter certainly not less than nine times that of the earth's orbit, and the average velocity of Sirius in that orbit would be not less than a fifth of the earth's velocity in her orbit, while when nearing perihelion a much greater velocity than this might be attained. Supposing that a portion of the velocity which is in the direction towards and from us to be about ten miles per second, and the system to be travelling at about the same rate from the sun, the apparent velocities in the direction of the line of sight would range from rest to a rate of recession of about twenty miles per second.

Whatever be the actual movements of Sirius, orbital or otherwise, it is clear that the new method of measuring motion is capable of giving us such information about these movements as cannot but help us notably in the determination of their true character. The same method applied to Procyon and other leading stars will probably do more to enable science to interpret the constitution of the stellar heavens than any method devised since astronomy became a science.

THE CHEMISTRY OF COOKERY.

XXXV.

By W. MATTIEU WILLIAMS.

"Pease-pudding hot, pease-pudding cold,
Pease-pudding in the pot, nine days old."

I LEAVE to Mr. Clodd the historical problem of determining whether this notable couplet is of Semitic, Aryan, Neolithic, or Paleolithic origin. Regarded from my point of view it expresses a culinary and chemical principle of some importance, and indicates an ancient practice that is worthy of revival.

I have lately made some experiments on the ensilage of human food, whereby the cellular tissue of the vegetable may be gradually subjected to that breaking up of fibre described in No. 28. One of the curious ahcievements of chemical metamorphoses that is often quoted as a matter for wonderment is that of converting old rags into sugar by treating them with acid. The wonderment of this is diminished, and its interest increased, when we remember that the cellulose or woody fibre of which the rags are composed has the same composition as starch, and thus its conversion into sugar corresponds to the every-day proceedings described in No. 30. All that I have read and seen in connection with the recent ensilage experiments on cattle fodder indicate that it is a process of slow vegetable cookery, a digesting or maceration of fibrous vegetables in their own juices which loosens the fibre, renders it softer and more digestible, and not only does this, but, to some extent, converts it into dextrine and sugar.

I hereby recommend those gentlemen who have ensilage-pits and are sufficiently enterprising to try bold experiments, to water the fodder, as it is being packed down, with dilute hydrochloric acid or acetic acid, which, if I am not deluded by plausible theory, will materially increase the sugar-forming action of the ensilage. The acid, if not over-supplied, will find ammonia and other bases with which to neutralise itself.

Such ensilage will correspond to that which occurs when we gather Jersey or other superlatively fine pears in autumn as soon as they are full grown. They are then hard, woody, and acid, quite unft for food, but by simply storing them for a month, or two, or three, they become lusciously

soft and sweet, the woody fibres are converted into sugar, the acid neutralised, and all this by simply fulfilling the conditions of ensilage, viz., close packing of the fibre, exclusion of air by the thick rind of the fruit, *plus* the other condition which I have just suggested, viz., the diffusion of acid among the well-packed fibres of the ensilage material.

In my experiments on the ensilage of human food I have encountered the same difficulty as that which has troubled graziers in their experiments, viz., that small-scale results do not fairly represent those obtained with large quantities. There is besides this another element of imperfection in my experiments respecting which I am bound to be candid to my readers, viz., that the idea of thus extending the principle was suggested in the course of writing this series, and, therefore, a sufficient time has not yet elapsed to enable me (with much other occupation) to do practical justice to the investigation.

I find that oatmeal porridge is greatly improved by being made some days before it is required, then stored in a closed jar, brought forth and heated for use. The change effected is just that which theoretically may be expected, viz., a softening of the fibrous material, and a sweetening due to the formatiou of sugar. This sweetening I observed many years ago in some gruel that was partly eaten one night and left standing until next morning, when I thought it tasted sweeter, but to be assured of this I had it warmed again two nights afterwards, so that it might be tasted under the same conditions of temperature, palate, &c., as at first. The sweetness was still more distinct, but the experiment was carried no further.

I have lately learned that my ensilage notion is not absolutely new. A friend who read my Cantor lectures tells me that he has long been accustomed to have seven dishes of porridge in his larder, corresponding to the days of the week, so that next Monday's breakfast was cooked the Monday before, and so on, each being warmed again on the day fixed for its final execution, and each being thus seven days old. He finds the result more digestible than newly-made porridge. The classical nine days' old pease-pudding is a similar anticipation, and I find, rather curiously, that nine days is about the limit to which it may be practically kept before mildew—mouldiness—is sufficiently established to spoil the pudding. I have not yet tried a barrel full of pease-pudding or moistened pease-meal, closely covered and powerfully pressed down, but hope to do so.

Besides these we have a notable example of ensilage in saur-kraut—a foreign luxury that John Bull, with his usual blindness, denounces, as a matter of course. "Horrid stuff," "beastly mess," and such-like expressions, I hear whenever I name it to certain persons. Who are these persons? Simply Englishmen and Englishwomen who have never seen, never tasted, and know nothing whatever of what they denounce so violently, in spite of the fact that it is a staple article of food among millions of highly-intelligent people. Common sense (to say nothing of that highest result of true scientific training, the faculty of suspending judgment until the arrival of knowledge) should suggest that some degree of investigation should precede the denunciation.

In the cases of the saur-kraut and the ripening pear there is acid at work upon the fibre, which, as I have before stated, assists in the conversion of such indigestible fibre into soluble and digestible dextrin and sugar; but the demand for the solution of the vegetable casein or legumin, which has such high nutritive value and is so abundant in peas, &c., is of the opposite kind. Acids solidify and harden casein, alkalis soften and dissolve it. Therefore the chemical agent suggested as a suitable aid in the ensilage or slow cookery, or the boiling or rapid cookery, of leguminous food is such an alkali as may be wholesome and compatible with the demands for nutrition.

Now, the analyses of peas, beans, and lentils, &c., show a deficiency of potash salts as compared with the quantity of nitrogenous nutriment they contain; therefore I propose, as in the case of cheese food, that we should add this potash in the convenient and safe form of bicarbonate, not merely add it to the water in which the vegetables may be boiled, and which water is thrown away (as in the common practice of adding soda when boiling greens), but add the potash to the actual pease-porridge, pease-pudding, lentil soup, &c., and treat it as a part of the food as well as an adjunct to the cookery. This is especially required when we use dried peas, dried beans of any kind, such as haricots, dried lentils, &c.

I find that taking the ordinary yellow split-peas and boiling them in a weak solution of bi-carbonate of potash for two or three hours, a partial solution of the casein is effected, producing pease-pudding, or pease-porridge, or purée (according to the quantity of water used) which is softer and more gelid than that which is obtained by similarly boiling without the potash. The undissolved portion evidently consists of the fibrous tissue of the peas, the gelatinous or dissolved portion being the starch, with more or less of casein. I say "more or less" because at present I have not been able to determine whether or not the casein is all rendered soluble. The flavour of the clear pea-soup which I obtained by filtering through flannel shows that some of the casein is dissolved; this is further demonstrated by adding an acid to the clear solution, which at once precipitates the dissolved casein. The filtered pea-soup sets to a stiff jelly on cooling, and promises to be a special food of some value, but for the reasons above stated I am not yet able to speak positively as to its practical value. The experience of any one person is not sufficient for this, the question being, not whether it contains nutritive material—this is unquestionable—but whether it is easily digested and assimilated. As we all know, a food of this kind may "agree" with some persons and not with others—*i.e.*, it may be digested and assimilated with ease or with difficulty according to personal idiosyncrasies. The cheesy character of the abundant precipitate which I obtain by acidulating this solution is very interesting and instructive, regarded from a chemical point of view. The solubility of the casein is increased by soaking the peas for some hours, or, better still, a few days, in the solution of bicarbonate of potash.

Another question is opened by these experiments, viz., what is the character and the value of the fibrous solid matter remaining behind after filtering out the clear pea-soup? Has the alkali acted in an opposite manner to the acid in the ripening pear? Is it merely a fibrous refuse only fit for pig-food, or is it deserving of further attention in the kitchen? Should it be treated with dilute acid—say a little vinegar—to break up the fibre, and thereby be made into good porridge? Other questions crop up here as they have been cropping continually since I committed myself to the writing of these papers, and so abundantly that if I could afford to set up a special laboratory, and endow it with a staff of assistants, there would be some years' work for myself and staff before I could answer them exhaustively, and, doubtless, the answers would suggest new questions, and so on *ad infinitum*. I state this in apology for the merely suggestive crudity of many of the ideas that I throw out in the course of these papers.

Before leaving the subject of peas, I must here repeat a practical suggestion that I published in *The Birmingham Journal* about twenty years ago, viz., that the water in

which green peas are boiled should not be thrown away. It contains much of the saline constituents of the peas, some soluble casein, and has a fine flavour, the very essence of the peas. If to this, as it comes from the saucepan, be added a little stock, or some Liebig's Extract, a delicious soup is at once produced, requiring nothing more than ordinary seasoning. With care, it may form a clear soup such as just now is in fashion among the fastidious, but prepared however roughly, it is a very economical, wholesome, and appetising soup and costs a minimum of trouble.

I must here add a few words in advocacy of the further adoption in this country of the French practice of using as *potage* the water in which vegetables generally (excepting potatoes) have been boiled. When we boil cabbages, turnips, carrots, &c., we dissolve out of them a very large proportion of their saline constituents; salts which are absolutely necessary for the maintenance of health; salts, without which we become victims of gout, rheumatism, lumbago, neuralgia, gravel, and all the ills that human flesh with a lithic acid diathesis is heir to, *i.e.*, about the most painful series of all its inheritances. The potash of these salts existing therein in combination with organic acids is separated from these acids by organic combustion, and is then and there presented to the baneful lithic acid of the blood and tissues, the stony torture-particles of which it converts into soluble lithate of potash, and thus enables them to be carried out of the system.

I know not which of the Fathers of the Church invented fast-days and *soup maigre*, but could almost suppose that he was a scientific monk, a profound alchemist, like Basil Valentine, who in his seekings for the *aurum potabile*, the elixir of life, had learned the beneficent action of organic potash salts on the blood, and therefore used the authority of the Church to enforce their frequent use among the faithful.

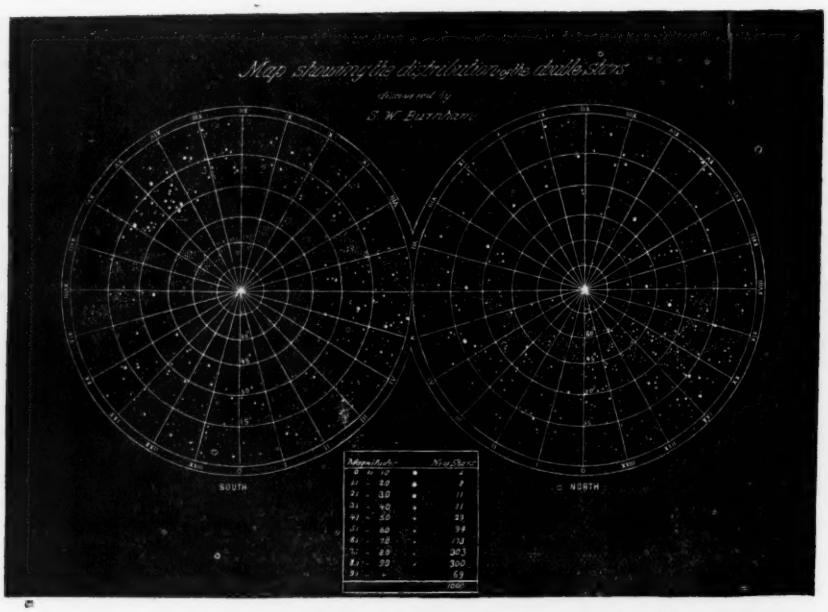
DESTRUCTION OF TELEGRAPH WIRE.—The Indians in Alaska are said to have used, in making salmon nets, the bulk of 900 miles of telegraph wire, which was laid by the Overland Telegraph Company many years ago, at a cost of 3,000,000 dols.—*Electrical Review.*

DOUBLE STARS.

By MR. S. W. BURNHAM.

(*Micrometrical Measures of* 748 *Double Stars made with the* 18½-*inch Refractor of Dearborn Observatory.**)

THE accompanying diagram was prepared in the first instance for my own information, concerning the distribution in space of the new double stars contained in this and the preceding catalogues. It then seemed that a reproduction of it might properly find a place at the close of the series. These double stars are as uniformly scattered over the surface of the sky as could be expected when due allowance is made for the unequal distribution of stars generally, and the difference in observing weather at different seasons of the year. The Milky Way, of course, furnishes a greater number of new double stars than the same area elsewhere; and that part of the heavens on the Meridian in the fall and summer months was more carefully examined, and with correspondingly better results.



No systematic search has been made for the discovery of new pairs. At this time, when comparatively so little has been done in the detection of really difficult objects, it is hardly worth while taking the necessary time to follow any special plan in looking for new pairs. No appreciable amount of time can be lost by the repeated examination of stars when the telescope is directed at random. A hundred years hence it may be desirable to make a careful systematic study of all the stars, not known to be double, down to the eleventh or twelfth magnitude, with the great refractors of that time, and especially if some location shall be found where a steady air and good definition can be had most of the time, at certain seasons of the year at least. Under such circumstances a thorough examination by an experienced observer of stars not catalogued as double would lead to valuable results, and would practically exhaust the field of discovery so far as the moderate or smaller apertures used in observatories now established are concerned.

* From the appendix of Mr. Burnham's fourteenth catalogue of double stars, recently published by the Royal Astronomical Society.

The Southern Hemisphere, however, is an almost untried field, particularly that portion within 40° of the South Pole. Very few close pairs have been discovered, and in the region mentioned there is probably not one double star known that would be called difficult with the telescope of this observatory. Assuming a uniform distribution of double stars in the Northern and Southern Hemispheres, several hundred fairly close pairs could be picked up with a small aperture of first-class definition without going below the eighth magnitude. A large number of close and unequal pairs will be found in the naked-eye stars.

The whole number of stars represented in the accompanying map is 1,000, of the following orders of brightness :—

Magnitudes.	No. of Stars.	Magnitudes.	No. of Stars.
0 to 1.0	2	5.1 to 6.0	94
1.1 „ 2.0	8	6.1 „ 7.0	173
2.1 „ 3.0	11	7.1 „ 8.0	303
3.1 „ 4.0	11	8.1 „ 9.0	300
4.1 „ 5.0	29	9.1 „ +	69
Total	—	—	1000

LIMITING DISTANCE OF NEW PAIRS.

My catalogues, particularly the earlier ones, contain a few stars which, from the distance of the components, it would have been better to reject. It may sometimes be desirable to record faint companions to bright stars and previously known pairs when they are beyond the ordinary limits of distance, but it is rare that the maximum distance of the Pulkowa Catalogue, 16″, should be exceeded, and in stars from 8 or 8.5 magnitude down, the companion should generally be within 5″ at the most. Pairs of this distance will rarely prove of much interest. All the rapid and interesting binaries are much closer.

Omitting some of the wider pairs, and also the close pairs which have not been measured, there are left 743 double stars out of 1,000 which are represented by the following mean distances :—

Magnitude.	No. of Stars.	Mean Distances. ″
3.1 to 4.0	6	1.88
4.1 „ 5.0	16	1.89
5.1 „ 6.0	61	1.80
6.1 „ 7.0	119	1.92
7.1 „ 8.0	240	1.36
8.1 „ 9.0	247	1.57
9.1 „ +	54	1.63
Mean distance of 743 stars =		1.58

In the early history of double-star astronomy, when for this work instruments were inferior as well as smaller, there might have been some excuse for including in a catalogue wide pairs, and those where both components were faint ; but at this time there is no justification for ever calling two tenth-magnitude stars which happen to be 5″ or 10″ apart a double-star in the proper sense of the term. At any time since the publication of the work of Struve the time spent in observing such objects would be little less than lost, and this will necessarily be the case for all time to come. Of course it is very easy to make with a telescope very moderate in size and indifferent in definition, an imposing catalogue of so-called discoveries, so far as numbers go, if these faint and wide couples are included ; but the value of such a list now, and in the future, will depend solely upon the number of first-class pairs it contains. The Pulkowa Catalogue, as given in Vol. IX. of the publications of that observatory, will serve as a model for this class of work so far as the element of distance is concerned. A close pair—that is, where the distance does not exceed 1″ should be recorded, however faint the components may be, and, of course, the magnitude of the companion to any star should have no weight in retaining or measuring it as a double-star.

An examination of the various double-star catalogues of original entry with reference to the proportion of close pairs is instructive as illustrating the relative number of systems of this kind in each, as well as showing the greater perfection of modern telescopes for this kind of work. Those of the Struves are so well known that further comment is unnecessary.

The seven catalogues of Sir John Herschel contain nine stars where the estimated distance is 1″ or less. Of this number I have examined and measured seven, the distances being 2″.5, 1″.81 ("violent suspicion," H., 1″.02 ("almost certain," H.), 2″.27, 3″.26, 1″.2 ("not verified," H.), and 1″.80. The remaining two could not be found, one being noted as doubtful by Herschel. So that at most we have only two pairs of Class I. Herschel gives 68 stars of Class II., estimated at 1½″ to 2″, all of which, with, perhaps, three or four exceptions, are below the ordinary limits of magnitude, most of them being from 10 to 12 magnitude. In all, about 24 of these stars have recently been observed, mostly at Cincinnati and Chicago, of which 16 exceed 2″ in distance, and four were not found as described, four pairs only coming within the limits of Class II. It is practically certain that of the remaining 44 stars there would not be more than a dozen that would come within the required distance. I have assumed the number, however, to be 20.

The following table gives all the principal original double-star catalogues published, and the number of pairs in each of Class I. (distance from 0″ to 1″) and Class II. (distance from 1″ to 2″). In the last column is given the ratio of stars of these classes to each thousand double-stars catalogued by the discoverer :—

	Class I.	Class II.	Total.	Ratio.
Burnham, Catalogue of 1,000 stars	226	254	520	520:1000
O. Struve „ „ 547 „	154	63	217	400:1000
Struve „ „ 2,640 „	91	314	405	150:1000
Herschel I. „ „ 812 „	12	24	36	45:1000
Herschel II. „ „ 3,429 „	2	20	22	7:1000
Alvan G. Clark	14	1	15	
All other observers	40	75	129	
			1344	

From this investigation we find the pairs having a distance not exceeding 2″ are less than 1,400 ; and it is safe to say that the total number of stars now known which can be properly called double is but little if any greater than 3,000, and that at least three-fourths of the remainder are not worth observing for any reason.

THE PATENT ACT OF 1883.

BY POLYGLOT.

(*Continued from page* 369.)

BE careful not to make your claims too wide ; because, if they embrace more than was new at the time you filed your application, even if the old part be of but minor importance, your whole patent is vitiated. Where an old part is used in a novel manner, and in connection with others that are new, it is often desirable to preface the claim with what is known as a "disclaiming clause," as in the following example, still referring to our supposed focussing gear :—"I am aware that racks have been previously applied to the focussing gear of photographic cameras, and I therefore do not claim such rack in itself, but what I claim is : The focussing gear for a photographic camera, consisting of a rack, a slotted guide, and a toothed wheel

with a thumb-screw, all substantially as described and shown in the drawings."

I have already mentioned that drawings must accompany the complete specification. As I have, however, given no particulars about mere formalities relating to the specification, I will follow the same rule with reference to the drawings.

Where no provisional specification is to be filed, the declaration previously spoken of will be accompanied by the complete specification, together with drawings where these are desirable.

Whether the complete specification has been filed in the first instance or after the provisional, it will be examined by the patent office. If it appears defective, the applicant is required to amend it; if it is found satisfactory, he is notified and the acceptance advertised. It is now open to inspection, and any one who has any objection to the grant of letters patent for the invention, or to the applicant, may oppose the issue of the patent. The grounds on which an opposition may be based are stated in the Act in these words:—

". . . . On the ground of the applicant having obtained the invention from him (*viz., the opposing party, P.*) or of a person of whom he is the legal representative, or on the round that the invention has been patented in this country on an application of prior date, or on the ground of an examiner having reported to the comptroller that the specification appears to him to comprise the same invention as is comprised in a specification bearing the same or a similar title, and accompanying a previous application *but on no other ground* (the Italics are mine, P.)."

Oppositions must be lodged within two months from the advertisement in the "*Patent Office Journal*" of the acceptance of a complete specification. If no opposition arises, or if the opposition is unsuccessful, the patent issues.

The patentee now has a title which he holds without any guarantee from the Government (or any one else for that matter) of its validity. The examination above spoken of is merely a comparison of the applicant's specification with those of others to whom patents have not been issued yet. As soon as the patent is granted, the invention is supposed to be known to the public at large, and the examiners cease to take any note of it. It therefore follows that holding of a patent is by no means proof of either the novelty, the utility, or the practicability of the invention. These must, perforce, be left to the judgment of the patentee, or to that of the courts of justice; but, in determining whether or not a patent is good, I think the courts will, as a rule, be inclined rather to give the patentee the benefit of a doubt than otherwise, unless his *bona fides* be questionable.

It may, however, be found that an invention, though embracing the whole or parts of another previously patented one, is yet a distinct advance upon such prior patent. Then, though the earlier patent bars the use of the second invention without the first patentee's consent until the first patent expires and thus becomes public property, yet the first patentee must equally refrain from using the second one's improvement.

If the first patent has still a considerable time to run, it is probably best if the two agree—sad to say, poverty often puts one man at the mercy of his richer opponent. If, however, the first patent has nearly run out, it may pay the second man to hold out and wait till it expires, as he then perchance may make money by his better apparatus or process.

The patentee, if his rights do not conflict with those of others, has the absolute and sole privilege to "make use, exercise, and vend" his invention to the entire exclusion of all others (with the exception of inventions for warfare, with regard to which certain special reservations have been made in favour of the Crown), and no one is entitled to counterfeit his invention or to interfere with his use thereof unless he employs it in a manner which is, *per se*, contrary to law. It is a very common error to suppose that any man may for his private use lawfully make a patented article. Whosoever does so without leave acts in contravention of the patentee's rights, is an infringer, and, as such, liable to be sued. The new Patent Act, however, contains a proviso according to which the Board of Trade may, under certain conditions, compel the patentee to grant licences for the use of his invention upon a fair consideration. Whether this section of the Act will ever be more than a dead letter, or whether it will work well or ill, remains to be seen. It is to be feared that the clause may lead to much trouble, and may sorely perplex inventors, poor ones especially, when they are attacked by rich and unscrupulous opponents. It has furthermore to be borne in mind that a patentee in selling an article made in accordance with his invention is held to have sold it with full licence for the free use thereof, unless there is an express understanding to the contrary.

Another point to be remembered is, that any one purchasing a counterfeit of a patented article, or an article infringing a patent, though he may have acted in perfect good faith, is yet liable to pay royalty for the use of such article; but he can, I think, seek redress at the hands of the vendor.

The privilege of a patentee lasts for fourteen years from the date of the application; during the first four years unconditionally, for the remaining term on condition that certain taxes, amounting in the aggregate to £150, be paid in such sums (from £10 to £20 per annum) as the Act directs.

I think I have now said as much on the subject as can conveniently be comprised within the limits prescribed by the nature of an essay like this. I have abstained from describing any of the procedure in oppositions and appeals, as no man ought to meddle with these without proper assistance, and can say nothing about law-suits connected with patent matters, which require to be dealt with by a better man, by far, than I am. In connection with this, I would only caution readers that all "law" is expensive, but suits in patent law are, by their very nature, doubly so, because in most cases they not only necessitate the assistance of first-class counsel — specialists in patent matters—but, moreover, almost invariably call for a great deal of costly expert evidence, and experts very frequently hold conflicting views on the questions submitted for their opinion.

I may summarise my experience about patents by saying that, though on the one hand there is no more valuable property than a good patent for a good invention, yet much caution is required before a man builds great hopes upon an invention. In every field of industry there are yet vast uncultivated spaces ready to yield a golden crop, but for its fruition business capacity, a sure insight into the wants of the public, and an untiring energy are needed quite as much as ingenuity and constructive skill.

I may conclude with the wish that what I have writ may prove instructive to some of the multitude of readers of KNOWLEDGE; and having begun, like the monks of old, with a salute to the reader, let me like them conclude with the greeting, "*Lector, vale.*"

GERMAN STEAM NAVIGATION.—A Bill has been submitted to the German Parliament proposing to grant State subventions to the extent of £204,750 to a line of steamers to Eastern Asia and Australia.

SENT TO THE BOTTOM.

By RICHARD A. PROCTOR.

(*Continued from page* 389.)

IT remains that I should touch on a form of danger to which ocean-going steamers are exposed on certain well-frequented routes,—a danger more subtle and terrible even than the risk of collision. I refer to the danger of running on an iceberg in the night time. It can hardly be doubted that among those splendid steamers which have started under seemingly favourable conditions on the journey between America and Europe, well manned, well provisioned, and well formed in all respects, and have never more been heard of, some have been lost through collision with an iceberg. The stories of narrow escapes, of cases where an iceburg has been passed within a stone's throw, or of even narrow escapes where an iceberg has been actually struck, but the strength of the ship's compartments have saved her from foundering, show how reasonable is this explanation of the loss of ships which could have outridden almost any storm that has ever raged in the North Atlantic. On a dark night there may be no warning even when there is no haze. The keenest watchman cannot detect the outline of one of these long, low icebergs which have been approached even in full daylight, with bare time to escape their formidable sides. When there is the least fog a low-lying iceberg is a still more treacherous enemy.

If we consider the case of the *Arizona*, in October, 1879, we shall see how subtle are the risks which icebergs and icefields cause, even when a ship is in the hands of the most careful commander. I was a passenger by her on the journey to New York preceding the accident, which occurred on the return voyage. I remember discussing with one of the officers (not when he was on duty, courteous reader) the risks from icebergs, and his admission that there was no way of ensuring safety from a danger so subtle, especially in the case of so swift a ship as the *Arizona*. On the return voyage, she was steaming gaily along at the rate of more than fifteen knots an hour; it was night, and there was no thought of danger, still less of disaster; some of the passengers were engaged in the saloon in the dignified employment of speculating on the day's run (to the following noon); when a shock which threw most of the speculators to the floor showed that whatever run she might make would certainly be far short of the high numbers on which they had been wagering. In a few moments every one was on deck, watching the dim outlines of two towering ice pinacles, which seemed to threaten the ship's immediate destruction. But when she had been backed from her dangerous proximity to the iceberg, it was seen that she was exposed to a still more serious danger,—she was settling down (apparently) by the head, with a list to starboard, which showed that a side compartment as well as her forward one had been broken into by the force of the shock. Fortunately the builders had done honestly by the owners. The stout framework and bulwarks of the compartments held firmly, and though crippled she remained afloat. She did not, however, complete her journey to the old country, but bore up to St. John's, N.B., to refit.

Now seeing that the most careful watch and the keenest eyes do not suffice to save a ship from the danger of collision with an iceberg, the question arises whether science cannot provide a keener sense than human eyesight to provide safety against this terrible danger. The only sense which seems available, failing the sense of sight, is the sense by which heat is perceived (properly distinguished long ago by Stewart Reid from the sense of touch, and undoubtedly to be regarded as our sixth sense). The fall of tempera ture, however, as an iceberg is approached, though very obvious near by, is not recognisable at a sufficient distance or with sufficient quickness, by human sense-organs. What is wanting is a scientific heat-feeler or temperature-noter, by which an iceberg half a mile away or more could be recognised. There are some heat measurers which are so delicate that they respond to the heat of a cigar burning ten or twelve yards away, and to even slighter sources either of heat or of cold, that is either of rise or fall of temperature. Now imagine a suitably-constructed instrument of this sort, adjusted for the actual temperature of the region through which the ship was passing; then the approach of the ship to an iceberg even some half-mile or so away would cause the index to move to the side showing cold, through an appreciable angle, the deviation increasing every second as the ship advanced. Nothing could be easier than to make the index antomatically start suitable alarm ignals,—horn, whistle, or the like; and on moving further over to the cold side, causing the engineers to receive warning to slow or stop their engines; nay the index could easily, if it were thought desirable, be made to set mechanism in motion for stopping and reversing the engines.

An instrument such as this might also be so constructed as to show the direction of the source of danger—for if there were (say) a triple indicator one directed forwards, another towards the port quarter, and the third towards the star board quarter, the first to signal an iceberg would be the one whose face was directed nearest to the point where the iceberg lay. The two quarter indicators would in this case rather show the neighbourhood of ice than the presence of any actually dangerous ice mass. But whenever the side indicators told of icebergs, it would be seen that there was occasion for very careful watch, and cautious progress.

Certainly, when we remember with what zeal science is applied to the invention of contrivances by which life and property may be destroyed—the long range guns, mitrailleuses, torpedoes, and the like which afford such striking evidence of our advance beyond the savage (who can only smash a single head by main force with his club, or pierce one body with his spear)—it seems as though science might with advantage devote a small portion of her ingenuity to the invention of measures whereby life and property may be preserved. The law of the survival of the fittest would still operate as effectively when science is applied to preser vation as when it is applied to destruction; and Science could have afforded an answer to those who ask whether despite the improvement in our appliances for travel, transit of goods, manufactures, and so forth, the influence of increased knowledge has always been such as to justify the aspiration

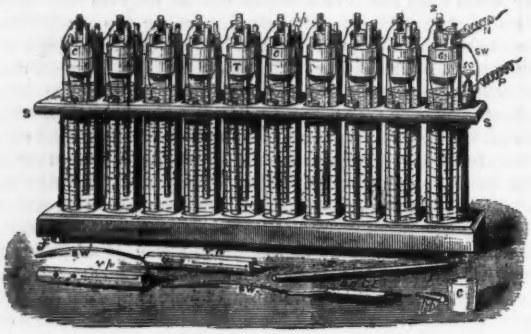
Let Knowledge grow from more to more.

THE AMATEUR ELECTRICIAN.

BATTERIES.—X.

THE only other form of battery to which we deem desirable to draw attention is the one introduced by Messrs. Warren de la Rue, and Hugo Müller. Although reserved till the conclusion of this series of papers, the cell is not by any means the least important or useful of those referred to. On the contrary, there is every probability that it is destined to be extensively adopted by experi mentalists, and for certain species of practical applications

In the accompanying illustration is depicted a tray containing ten cells. There are also illustrated the various parts of which each cell is composed. The outer, or containing vessel, is a glass tube about 1 inch in diameter, and 5½ inches long. A paraffin stopper (c) is made to fit the tube, and is provided with two holes, through one of which the positive plate, consisting of a zinc rod (z) $\frac{3}{16}$ inch in diameter, is passed and fixed by means of a little melted paraffin. The negative plate is pressed or wedged in



between the stopper and the glass, and consists of a flattened silver wire (SW) around which is cast a quantity of chloride of silver (AgCl) until a thickness of five-sixteenths of an inch is attained. Through the second hole in the stopper a solution of ammonic chloride (containing 2½ per cent. of salt) is poured. The cell is then complete. When the circuit is made by joining the silver and zinc, a current is produced of great constancy. The zinc acting with a double equivalent of the ammonic chloride ($2NH_4Cl$) produces chloride of zinc ($ZnCl_2$), and sets free two equivalents of ammonia ($2NH_3$). The remaining hydrogen (H_2) acts on two equivalents of the silver chloride ($2AgCl$) and producing two equivalents of hydrochloric acid ($2HCl$) releases the silver (Ag_2). The action may be represented by equation thus :—

$$Zn+2NH_4Cl+2AgCl=ZnCl_2+2NH_3+2HCl+Ag_2.$$

The ammonia and hydrochloric acid thus produced combine to form two new equivalents of ammonic chloride, so keeping the quantity of that salt constant. The net result, in the absence of secondary reactions, is the gradual decomposition of the silver chloride, the solution of the zinc, and the accumulation of chloride of zinc. The silver is separated in a spongy form in the neighbourhood of the silver plate or wire, the available surface of which is thus being constantly increased. It will be seen that the principles involved are almost identical with those pertaining to the Daniell cell, the fused and insoluble chloride of silver taking the place of the soluble sulphate of copper. The insolubility of the silver salt obviates the necessity for using a porous pot, and therefore the internal resistance of the cell is very materially affected for the better. The use of so small a zinc rod is warranted by the absence of chemical action during the time the cell is not producing a current. Our readers will doubtless remember that the Leclanché cell was described as one capable of lasting a year or more from a similar cause. Mr. De la Rue stated, in 1882, that he had a battery made up six years previously, and which was still in action, loss of the fluid by evaporation having been from time to time made up. The electromotive force of the cell is 1·03 volts, or nearly that of a Daniell cell, which is 1·079.

In consequence of the small compass which the cell occupies and its non-wasteful properties, it lends itself remarkably to the requirements of the experimentalist who wishes at a moment's notice to produce a reliable current of considerable force. Mr. De la Rue had the cells grouped in trays containing twenty (sometimes more), and the trays placed in cabinets containing in some instances 1,200 cells, in other 2,160 cells. His entire battery thus made upon comprised 14,400 cells, which joined "in series" gave an electro-motive force of 14,832 volts. With the aid of such a battery (the largest ever employed in one continuous circuit) many most interesting experiments were performed bearing on the characteristic features of lightning, the aurora, and other phases of atmospheric electricity. Occasion may present itself later on to dilate upon this most important and little-known topic, but for the present we can only mention that the results of Mr. De la Rue's and other investigators' experiments demonstrate that, to produce a lightning discharge one mile long, a potential equal to that derived from upwards of 3,000,000 cells would be required.

It may be mentioned that one of the applications of the chloride of silver battery (the name by which the De la Rue cell is generally known) is in the "electric gas lighter." In this ingenious piece of apparatus, which is certainly unpretentious in appearance, a small ebonite tube, containing a miniature induction coil, is screwed on to another similar tube containing the cell. On pressing a little button, the current passes through the primary circuit of the induction coil, and induces a current in the secondary coil. The induced spark passes between two points, and, if the end of the apparatus carrying the points is placed in the escaping gas, ignition takes place.

Summing up what has been said on the various forms of battery in use, their several applications may be thus briefly noticed :—

1. Where a continuous steady current is required, more particularly if not of unusually high electro-motive force, the Daniell or one of its modifications stands pre-eminent, and its continued use in telegraphy and electro-chemistry is fully justified.

2. Where a current of high electro-motive force is necessary, and where its duration is required for a few hours (as in electric-light experiments) the Grove, Bunsen, or double-liquid Bichromate should be employed, preference being given to the Grove if the battery has to be carried about, or if space is a consideration. Its compact construction gives it this advantage. The Bunsen lasts longer than the Grove because its cylindrical form, &c., involves the use of larger quantities of acids, and which, therefore, are less rapidly decomposed or diluted. The objection to the Bichromate is the greater trouble involved in the preparation of its solution, but it has the advantage of not producing fumes of nitric peroxide, the evolution of which renders the adoption of the Grove or Bunsen in a room highly objectionable.

3. Where currents are only required at intervals, more particularly if the intervals are long and the time during which the current is called for short, none can beat the Leclanché.

The chloride of silver cell may be used to suit requirement 1, but is perhaps more applicable to requirement No. 3.

The frequent demands on our space have necessitated the omission of a few forms of battery to which we should have liked to refer in order to make the series more complete; but it is hoped that, notwithstanding these unavoidable ostracisms from our original programme, our readers will have seen much that is useful and instructive, and, furthermore, that they will be enabled to decide upon the battery most suited to any particular work. To so enable them was our primary object in writing.

FOUCAULT'S PENDULUM EXPERIMENTS.

By RICHARD A. PROCTOR.

SCIENCE owes to M. Foucault the suggestion that the motions of a pendulum so suspended as to be free to swing in any vertical plane might be made to give ocular demonstration of the earth's rotation. The principle of proof may be easily exhibited, though, like nearly all the evidences of the earth's rotation, the complete theory of the matter can only be mastered by the aid of mathematical researches of considerable complexity. Suppose A B (Fig. 1) to be a straight rod in a horizontal position bearing the

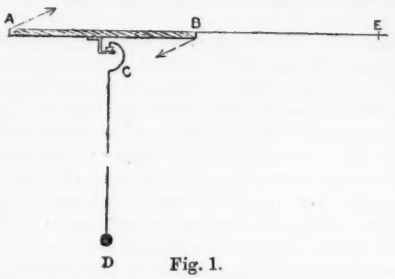


Fig. 1.

free pendulum C D suspended in some such manner as is indicated at C; and suppose the pendulum to be set swinging in the direction of the length of the rod A B, so that the bob D remains throughout the oscillations vertically under the rod A B. Now, if A B be shifted in the manner indicated by the arrows, its horizontality being preserved, it will be found that the pendulum does not partake in this motion. Thus, if the direction of A B was north and south at first, so that the pendulum was set swinging in a north-and-south direction, it will be found that the pendulum will still swing in that direction, even though the rod be made to take up an east-and-west position.

Nor will it matter if we suppose B (say) fixed and the rod shifted by moving the end A horizontally round B. Further, as this is true whatever the length of the rod, it is clear that the same fixity of the plane of swing will be observed if the rod be shifted horizontally, as though forming part of a radial line from a point E in its length. In these cases the plane of the pendulum's swing will indeed be shifted *bodily*, but the direction of swing will still continue to be from north to south.

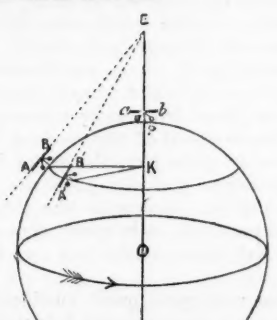


Fig. 2.

Now, let P O P' represent the polar axis of the earth; *a b* a horizontal rod at the pole bearing a pendulum, as in Fig. 1. It is clear that if the earth is rotating about P O P' in the direction shown by the arrow, the rod *a b* is being shifted round, precisely as in the case first considered. The swinging pendulum below it will not partake in its motion; and thus, through whatever arc the earth rotates from west to east, through the same arc will the plane of swing of the pendulum appear to travel from east to west under *a b*.

But we cannot set up a pendulum to swing at the pole of the earth. Let us inquire, then, whether the experiment ought to have similar results if carried out elsewhere.

Suppose A B to be our pendulum-bearing rod, placed (for convenience of description merely) in a north-and-south position. Then it is clear that A B produced meets the polar axis produced (in E, suppose), and when, owing to the earth's rotation, the rod has been carried to the position, A' B', it still passes through the point E. Hence it has shifted through the angle A E A', a motion which corresponds to the case of the motion of A B (in Fig. 1) about the point E,* and the plane of the pendulum's swing will therefore show a displacement equal to the angle A E A'. It will be at once seen that for a given arc of rotation the displacement is smaller in this case than in the former, since the angle A E A' is obviously less than the angle A K A'.† In our latitude a free pendulum should seem to shift through one degree in about five minutes.

It is obvious that a great deal depends on the mode of suspension. What is needed is that the pendulum should be as little affected as possible by its connection with the rotating earth. It will surprise many, perhaps, to learn that in Foucault's original mode of suspension the upper end of the wire bearing the pendulum-bob was fastened to a metal plate by means of a screw. It might be supposed that the torsion of the wire would appreciably effect the result. In reality, however, the torsion was very small.

Still, other modes of suspension are obviously suggested by the requirements of the problem. Hansen made use of the mode of suspension exhibited in Fig. 3. Mr. Worms,

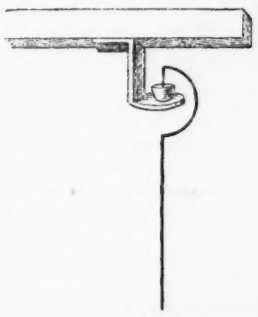


Fig. 3.

Fig. 4.

in a series of experiments carried out at King's College, London, adopted a somewhat similar arrangement, but in place of the hemispherical segment, he employed a conoid, as shown in Fig. 4, and a socket was provided in which the conoid could work freely. From some experiments I made myself a score of years ago, I am inclined to prefer a

* In reality A E moves to the position A' E over the surface of a cone having E P' as axis, and E as vertex; but for any small part of its motion, the effect is the same as though it travelled in a plane through E, touching this cone; and the sum of the effects should clearly be proportioned to the sum of the angular displacements.

† In fact, the former angle is less than the latter, in the same proportion that A K is less than A E, or in the proportion of the sine of the angle A E P, which is obviously the same as the sine of the latitude.

plane surface for the conoid to work upon. Care must be taken that the first swing of the pendulum may take place truly in one plane. The mode of liberation is also a matter of importance.

Many interesting experiments have been made upon the motions of a free pendulum, regarded as a proof of the earth's rotation; and when carefully conducted, the experiments have never failed to afford the most satisfactory results. Space, however, will only permit me to dwell on a single series of experiments. I select those made by Mr. Worms in the Hall of King's College, London, in the year 1859:—

"The bob was a truly turned ball of brass weighing 40 lb., the suspending medium was a thick steel wire; the length of the pendulum was 17 ft. 9 in. The amplitude of the first oscillation was 6° 42′, and during the time of the experiment—about half-an-hour—the arcs were not much diminished. As I had to demonstrate to a large number of spectators, I encountered considerable difficulty," says Mr. Worms, "in rendering the small deviations of the plane of oscillation visible to all. I accomplished it in three different ways." These he proceeds to describe. He had first a set of small cones set up, which were successively knocked down as the change in the plane of the pendulum slowly brought the pointer under the bob to bear on cone after cone. Secondly, a small cannon was so placed that the first touch of the pendulum-pointer against a platinum-wire across the touch-hole, completed a galvanic circuit, and so fired the cannon. Lastly, a candle was placed so as to throw the shadow of the pendulum-bob upon a ground-glass screen, and so to exhibit the gradual change of the plane of swing.

The results accorded most satisfactorily with the deductions from the theory of the earth's rotation.

THE ENTOMOLOGY OF A POND.

By E. A. Butler.

THE SURFACE (*continued*).

A LITTLE creature called *Velia currens*, something like a small *Gerris*, but rather stouter and still more spider-like, is one of the commonest objects on every piece of water, seeming, however, to prefer parts where the surface is not too placid. It is about one-third of an inch in length, of a dark brownish colour, with orange markings. Dozens of them, consisting of individuals of various ages, may often be seen congregating in a quiet corner, or even sometimes just under a spot where a miniature waterfall supplies sufficiently rapid streams to call forth all their energies in order to keep themselves from being carried

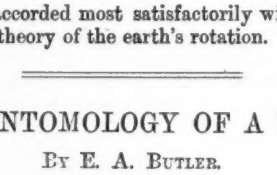


Fig. 1.—Velia Currens. Winged.

away by the current. This insect is almost always destitute of wings, but very occasionally a few examples are found fully developed, with dark-brown wings, adorned with a few snow-white spots. (Fig. 1.) A minute relative of Velia, *Microvelia pygmæa*, occurs sometimes on the surface of streams, but being only one-sixteenth of an inch long, it needs close looking for. It is black, marked with grey.

The other section of the surface fauna is Coleopterous, and its strangest representatives are, unquestionably, the beetles called "Whirligigs, (Fig. 2,) which constitute the

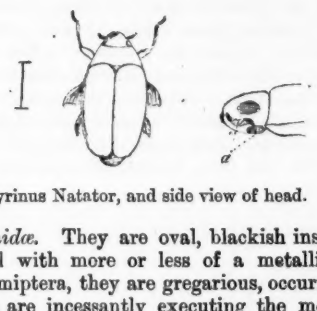


Fig. 2.—Gyrinus Natator, and side view of head. a.—Eyes.

family *Gyrinidæ*. They are oval, blackish insects, highly-polished, and with more or less of a metallic reflection. Like the Hemiptera, they are gregarious, occurring in little troops which are incessantly executing the most intricate gyrations, crossing one another's paths again and again, apparently in the most aimless manner, but really with that supreme end in view, the obtaining of food. When watching a company, one sometimes becomes conscious of a sudden diminution in their numbers, some individuals seeming to vanish; a careful scrutiny, however, detects the missing members at some depth in the water, whither they have temporarily dived, in consequence of some sudden scare. Presently, one by one they rejoin their comrades and at once begin again to take part in the mazy evolutions which seem the chief business of their life. Suppose, now, we have managed to secure some specimens from the lively company. Our first observation will undoubtedly be that they smell most disgustingly; in fact, they exude a fœtid milky fluid from various parts of their bodies, which must make them uncommonly nasty morsels to any creature that has the temerity to try to make a meal of them. Now these Gyrini are wonderfully well protected against possible foes; besides their horrid smell, which one would think might be almost enough by itself, there is the hard armour in which they are encased, the highly polished and well rounded surface of which renders them extremely difficult to hold. Then there is a most remarkable arrangement of the eyes, which gives them full command of both elements, air and water: the two customary eye-masses are each sub-divided into two sets by a pit, in which the attachment of the antenna is lodged: this throws one set on to the upper part of the head and the other completely beneath (Fig. 2a), a most excellent distribution, the reason for which is obvious. As the insect rests on the water, its eyes would, if normally placed, just come in line with the surface, the instability of which would considerably interfere with distinctness of vision: to obviate this difficulty, therefore, one is placed sufficiently above, and the other sufficiently below, to be out of the reach of the disturbing effects of surface irregularities, the upper being used for the vision of terrestrial and aërial, and the lower for that of sub-aqueous objects. Creatures like this, active, hard, malodorous, and possessed, so to speak, of quadruple vision, cannot but be well able to hold their own in the struggle for existence.

The legs have undergone great modification; the two hinder pairs are much shortened and flattened, the terminal joints reminding one somewhat of the fin of a fish. The front pair are of ordinary form, and considerably longer than the others, and are used for seizing the prey, which consists of small insects. The elytra are strongly arched and cover a pair of ample wings, whereby the creature is enabled to migrate from pond to pond when the water gets

low, a feat which, owing to the peculiar formation of the legs, would be impracticable in any other way. In their earlier stages, also, these insects are peculiar. The eggs are laid in rows on water-plants, and the larvæ proceeding from them look something like aquatic centipedes, for they are flattened and elongate, and behind the six legs, on the anterior segments, carry on each successive segment a pair of filamentous appendages, one on each side, not locomotive, however, but respiratory in function. After a predatory life below the surface the larva climbs some water-plant, and, having found a comfortable resting-place *out* of the water, spins there a paper-like oval cocoon, whence in due time the beetle issues, ready to descend again to its native element.

We may also class with the surface fauna certain beetles which, though not strictly aquatic, take up their abode on water-plants, such as water-lilies, the broad leaves of which form so many floating islands. They are chiefly stout-legged, large-footed insects, belonging to the genus *Donacia*, which contains nineteen British species, all vegetable-feeders, and attached to water-plants. They are clothed with hard integuments adorned with gorgeous colours, which glisten in the sunshine like gems, and as they are gregarious, the little companies that may sometimes be seen assembled on one of their leaf-islands, form a picture the beauty of which cannot be realised by those who have only seen the insects, bereft of all the sparkling glow of life, arranged in orderly rows on little pieces of cardboard in the collector's cabinet. Their larvæ live in the stems of water-plants, and the pupæ are enclosed in transparent silken cocoons. These beetles are essentially children of the sun, and are found principally during the three summer months.

Sometimes the leaves of water-lilies are found to be pierced with numerous holes; these are marks of the presence of the larvæ of another beetle, of no very handsome appearance, named after the plant, *Galeruca nymphææ;* its whole life is spent upon the leaf, which forms its food as well as resting-place; the larvæ flourish on their succulent diet, and soon acquire considerable obesity, and they and the compact pupæ may frequently be seen from a distance dotting the surface of the leaf as so many dark specks.

From the point of view of the entomological collector, no account of the surface fauna would be considered complete without a reference to those hapless insects whose floating corpses testify to the frequency of tragedies which terminate in "accidental death by drowning." High winds, driving before them frail creatures whose feeble wings have betrayed the trust too readily reposed in them, or blowing less venturesome ones off the trees and plants to which they have vainly endeavoured to cling, are the chief cause of these catastrophes; but when such tempting feasts as are to be found in the honey of sallow blossom hang over a pool, the surface beneath is often strewn with insects, chiefly moths, which, having imbibed too freely of the intoxicating juice have fallen off their perches in drunken inanity, and paid for their intemperance with their lives. Delicate insects such as these are, of course, pretty sure to be completely spoilt by the water, but those of stouter and stronger build are often none the worse for many hours' immersion; any surface of water, therefore, is always regarded by the collector as a good trap during a high wind.

(To be continued.)

THE Congress on electrical units which met in Paris last week, has decided unanimously that the length of the column of mercury of one square millimètre section which shall represent the legal ohm., shall be 106 centimètres. This is equal to 1·0114 B.A. units (the standard at present in use).

THE INTERNATIONAL HEALTH EXHIBITION.

BY JOHN ERNEST ADY.

II.

["John! Did you shake that bottle of beer? No, Sir, but I *will*." (*Shakes the bottle.*)—*Explosion and John's exit accelerated.*]

TO enter into the philosophy of the question why John should have retired precipitately would seem to be ridiculous to most persons, yet, nevertheless, there must have been some weighty reason for such a procedure. Of course, everybody knows *why* the bottle ought not to have been "shaken before taken," but few are aware of the fact, that in the sediment at the bottom lies the secret of the excellence of bottled beer,—its sparkling property and sharpness are due to the presence within it of carbonic acid gas (carbon dioxide).

It has hitherto been the practice of beer-bottlers to allow the process of fermentation to go on within the bottle after it has been sealed, or, in other words, to let nature supply the carbonic acid gas. But how is this effected?

Fig. 1.—*Saccharomyces Cerevisiæ*. The Yeast plant × 1,200 diameters. *a* shows a cluster of yeast cells developed from each other and remaining attached. The central spot is a space or vacuole, and it may be observed that in the oldest cell (the lowermost) it is largest, nearly all the protoplasm having dwindled away. The younger the cell the richer is it in protoplasm; *b* a cell crushed to show that it contains protoplasm (p), and cell-wall (w); *c* a single cell, stained magenta, to show that *v* is in reality a space, and not a denser portion or nucleus; *d* treated with caustic potash, dissolves the protoplasm, hence the vacuole vanishes. All the above may be taken as a condensed ordinary life-history of the yeast of beer.

The fermentative process is due to minute plants which constitute the yeast or "barm" of the brewer. Fig. 1 shows some of these plants magnified 1,200 diameters; they are each only about $\frac{1}{2000}$th of an inch in size. Their action upon the prepared malt or "wort" is to convert its cane into grape sugar, and to induce alcoholic fermentation in the latter; this they can only do *whilst living.** Moreover, all living things, whether plant or animal, require oxygen for their respiration, and eliminate carbonic acid gas. Now, when the beer is ready for consumption, some of the yeast yet remains to be got rid of. Those yeast cells which have lived their little day have performed their functions and decayed; their bodies sink to the bottom, and, if allowed to remain there, would eventually rot away; decomposition brings in a crowd of other forms of life, invariably heralded by the *mycoderma*, which turns the beer sour, and *bacteria* soon follow with putrescence in their wake. Let us not anticipate the forms of bacteria

* Hence the alcoholic ferment is called an *organised* ferment, to distinguish it from that other ferment which yeast possesses, and which can convert cane into grape sugar independently of the *life* of the plant. According to *Pasteur*, about ninety-eight per cent. of the sugar is resolved into alcohol, carbonic acid gas, and a very small proportion of glycerine and succinic acid. The remaining two per cent. of the sugar is appropriated by the plant in the form of nutriment.—J. E. A.

called *bacilli*, some of which bring with them all the forms of malignant disease, from consumption to splenic fever and leprosy, which our physicians lay to their charge. But to return to our subject, the bottled beer, with its small percentage of yeast, gains carbonic acid gas, and the yeast plants, no longer able to live without oxygen and sugar, die; their bodies subside and form the undesirable sediment alike unpalatable and deleterious.

When we promised to visit the Western Gallery to view the process of beer aëration, we did so with the sincere purpose of bringing to the notice of our readers a machine which has of late caused some stir in the scientific world, inasmuch as through its employment all harmful sub-

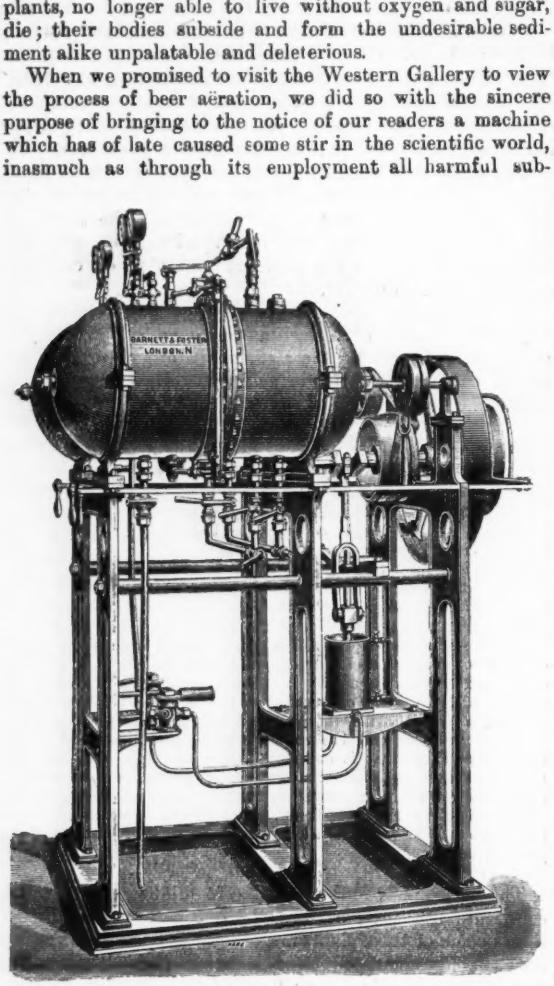


Fig. 2.—Messrs. Barnett & Foster's Beer Aërating Machine.

stances are expelled from the beer, and in consequence a beverage of great value secured.* To our mind, as to that of all rational physiologists, the human frame cannot be sustained "on bread alone;" proteids, starches, fats, salts, and *a small quantity of alcohol* are necessary for the maintenance of the body in the highest degree of vigour, especially when it is called upon to exercise manual functions. Most of the alcoholic drinks vended in the market are teeming with impurities, such as toxic oils and adulterations in the spirits and wines, and disagreeable sediments in the beers. To these causes are to be ascribed the nausea, headaches, and general debility which follow upon moderate potions.

We therefore hail with delight any improvement which is calculated to mitigate such evils, and must look upon the inventors in the light of public benefactors. To Messrs. Barnett and Foster, of the "Niagara" Works, Eagle Wharf-road, London, N., belongs the honour of having introduced an antidote in the shape of their beer aërating machine, and we cannot do better in this place, than, without any further preamble, give some account of their admirable contrivance.

The beer aërating machine of Messrs. Barnett and Foster is depicted at Fig. 2. Through its means all the air contained in any ordinary beer is first of all exhausted (pity the poor yeast plant). Fermentation thus becomes almost impossible, whilst greater scope is allowed for the incorporation of the carbonic acid gas than would otherwise, as in previously adopted methods, be the case.

There are two large cylinders, each capable of holding a barrel of beer, and these are made to work alternately, the one preparing, whilst bottling is carried on from the other (an obvious saving in time, *ergo* expenditure, the criterion of a well-devised mechanism). The air is first of all exhausted from the beer, and carbonic acid gas then forced into its place, until about 20 lbs. on the square inch of pressure is indicated. The bottling of the liquid is thence assumed.

The process of bottling the beer thus charged is so novel and excellent that it deserves some mention here. Although it does not strictly come within our area to treat of such things, we think that the effective "caging of the bird when caught" *is* of some importance, and hence offer the plan we have been made cognisant of to our readers as something of general practical interest. The great thing about it is that a sparkling liquid can be bottled securely without any frothing up, or, as it is technically called, "fobbing."

Two pipes fitted with stops-cocks are in communication with the orifice of outlet, the one to admit the beer, the other a return pipe, in connection with the upper portion of the beer-containing cylinder. The operation is conducted thus:—The cock of the return-pipe is opened, and *the pressure within the cylinder and the bottle to be filled are thus equalised.* The other cock is then turned on, and the beer flows into the bottle by gravitation, thus effectually preventing the so-called "fobbing." These processes may be watched at Messrs. Barnett & Foster's stand, No. 1,156 in the western gallery, where Messrs. Ashby & Co.'s, of Staines' ales are being bottled by Messrs. Chapman & Wells, of Tanner's-hill, Deptford.

Another great stride in the aëration of drinking liquids may also be viewed in operation at the same stand, where the "Niagara" machine of Messrs. Barnett & Foster is being exhibited. We would draw special attention to this machine, because we have of late been made painfully aware of the great danger which sometimes accrues through metallic contamination and consequent poisoning from such beverages, which are usually consumed in vast quantities in this country, and looked upon by the innocent imbibers as harmless, because they are called non-intoxicating. The vast majority of sodawater and other apparatus are provided with agitating gear, for the purpose of forcing a maximum of carbonic-acid into the liquid. It stands to reason that these appliances, especially as they are necessarily made of copper, lead, &c., must undergo a certain amount of wear and tear, and this, in instances which have recently come under our notice, has occasionally gone on to an alarming extent, so that the aërated drinks produced have not fallen far short of rank poisons.

We are therefore constrained once more to congratulate Messrs. Barnett and Foster on their invention, the "Niagara" condenser, and in giving publicity to their design, we rest assured that we are doing a service of some

* Especially for invalids, ladies nursing, and others who require a moderate amount of alcohol in a light harmless pabulum, which shall be inexpensive yet palatable.—J. E. A.

importance to our readers, by asking them to participate in the knowledge we have gained through careful inspection.

Fig. 3 is a sectional diagram of one of these "Niagara" condensors. The water impregnated with the gas is pumped into a compartment, E, formed between an inner and an outer casing; and here the liquid rises as the pumping is continued, and goes on absorbing gas which passes through the water to fill the whole body of the condensor. This goes on until the now partially-charged liquid reaches the level, D, over a perforated plate there situated, through which it rains down, like a waterfall (Niagara), into the body of the cylinder. During this descent it absorbs a further quantity of the compressed gas which fills the cylinder, and finally accumulates in the lower part of the condensor, highly charged, and ready to be conveyed by pipes to the bottling-machine. An attached water-gauge indicates the quantity of aërated water within the body of the cylinder.

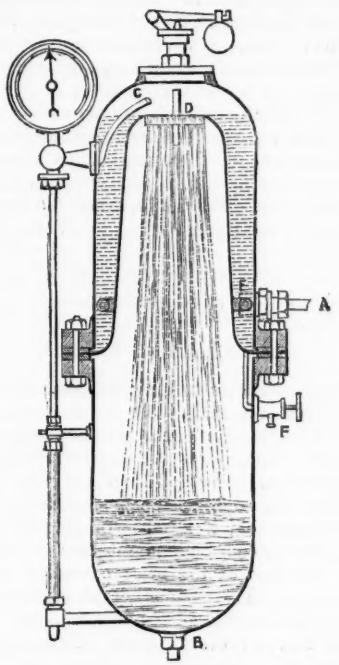


Fig. 3.—The "Niagara" Condenser, of Messrs. Barnett & Foster, for the Aëration of Soda, Potash, and other Waters.
(Diagrammatic Section.)

We can now easily understand how all metallic contamination is provided against in the slow rise of the water in the outer casing, and its downpour in a torrent through an atmosphere of compressed carbonic acid gas, by gravitation. These two simple operations dispense with agitators of all kinds, and produce the desired effect far more satisfactorily—viz., a maximum absorption, by the liquid, of carbonic acid gas.

Before leaving Messrs. Barnett and Foster's stand, we may briefly allude to the simple but effective contrivance employed in their bottling department. It will be seen that their improvements have been carried out in detail, and that the little as well as the great things have received due attention. Mr. Foster's improved bottle, called the "Intermittent," is provided with a screw-neck; the cap of stopper is somewhat larger than the neck of the bottle, and can thus be unscrewed with the utmost ease, thereby dispensing with the annoyance of corkscrews, whilst the stopper can be reinserted securely.

The plan adopted for bottling is ingenious. Fig. 4 shows the instrument employed. The stopper of the bottle is placed in a gripping holder inside the cup, under which the neck of the bottle is inserted, and, after the stopper has been drawn up by means of a winch handle, with which it is afterwards screwed into the bottle, hydraulic pressure is

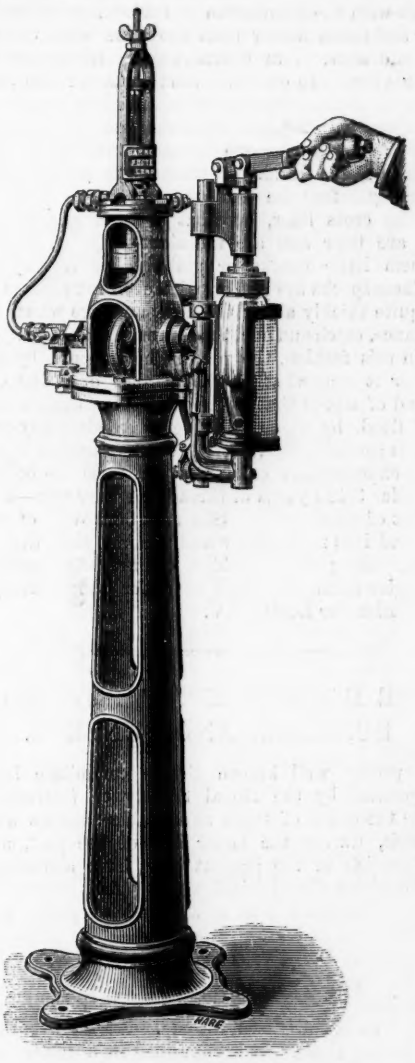


Fig. 4.—Barnett & Foster's "Excelsior" Bottling Machine for Aërated Waters, &c.

applied to an indiarubber collar, which makes a joint around the neck of the bottle and holds its firmly. The aërated liquid is then turned on to fill the bottle from a lateral orifice between the stopper and the mouth of the bottle. The stopper is then lowered and screwed on, and the bottling thus securely and neatly accomplished.

It is with regret that we are compelled to leave this interesting series of exhibits. We trust, however, that we have touched upon some of its more salient features, items which must always be of the first importance in any sanitary inquiry, and that what we have thus briefly noticed

may attract the attention of all those who are interested in the manufacture of aërated liquids in general, and the well-being of their fellow-creatures in particular.

SPIDER-LIFE WONDERS.

In a lecture at Boston, Massachusetts, Professor Wood dealt with the phenomena of spider life. The female is larger and much fiercer than the male, who, while paying his addresses, is in constant peril, frequently losing some of his legs. In one tribe the female is 1,300 times as large as the male. The spider's thread is made up of innumerable small threads or fibres, one of these threads being estimated to be one two-millionth of a hair in thickness. Three kinds of thread are spun:—One of great strength for the radiating or spoke lines of the web. The cross lines, or what a sailor might call the ratlines, are finer and are tenacious—that is, they have upon them little specks or globules of a very sticky gum. These specks are put on with even interspaces. They are set quite thickly along the line, and are what, in the first instance, catch and hold the legs or wings of the fly. Once caught in this fashion, the prey is held secure by threads flung over it somewhat in the manner of a lasso. The third kind of silk is that which the spider throws out in a mass of flood, by which it suddenly envelops any prey of which it is somewhat afraid, as, for example, a wasp. A scientific experimenter once drew out from the body of a single spider 3,480 yards of thread or spider silk—a length little short of three miles. Silk may be woven of spider's thread, and it is more glossy and brilliant than that of the silkworm, being of a golden colour. An enthusiastic entomologist secured enough of it for the weaving of a suit of clothes for Louis XIV.

THE RECENT EXTRAORDINARY SUNRISES AND SUNSETS.

It is pretty well known that a committee has been appointed by the Royal Society to (ostensibly) investigate the cause of those remarkable sunrises and sunsets which, during the latter half of the past, and the earlier portion of the present year, have attracted attention throughout the civilised world. As a matter of fact, this said committee was established to prove that the wonderful fore and after glows had their origin in the eruption of the Javan volcano Krakatoa, on Aug. 27, 1883; and as it would be worse than useless to send such evidence as I subjoin to this nice, impartial little association, I forward it to Knowledge instead. At all events, it will not be burked there. It is contained in a letter from Mr. E. Neison, F.R.A.S., F.C.S., &c., the Director of the Government Observatory at Natal (so well known as the author of our classical work on "The Moon"), and only reached me yesterday morning:—

"In England," says Mr. Neison, "you seem all busy over discussing the extraordinary sunsets. They began in Natal *in February*, 1883, but on a less grand scale, but gradually became more marked until *June*. Then for two months nothing was noticed. In the latter end of August they became most vivid. On the 21st and 22nd they were noticeable, but not vivid. The next five days were stormy, with much rain and lightning. On the 28th and 29th the sunsets were most vivid. The 30th was rainy. August 31 and September 1, 2, 3, and 5 were fine, and the vivid redness of the sky was most remarkable, fading away as it did into green and purple in the east. Then came a week of much rain, and the sunsets vanished, not to return for nearly four months, except in a very faint degree. In February and March of this year they again became very noticeable, but did not last so long. Now (April 2) they have gone again. Now for a remarkable point. In the Transvaal they were first noticed in the beginning of September—the 2nd, I think—and were most vivid until the end of January, though here, only some 250 miles off, nothing was seen. They disappeared, as far as I can gather, from the Transvaal in January. . . . . I am inclined to believe the sunsets to have been purely meteorological. Those in February, 1883, were sufficiently marked to induce me to try a water-colour sketch on February 8. It was spoilt next day by two visitors to the observatory, who upset a glass of water over it, smashing the glass and making general havoc. I got a specimen of the fine dust which fell on the ships in the Indian Ocean some days after the eruption of *Krakatoa*. *It was absolutely free from any metallic iron or mineral containing iron decomposed by hydrochloric acid*—pumice-stone pure and simple, I believe. I tested it expressly for iron in both these forms. It was a very fine greyish-white dust."

So, here was the Government Astronomer at Natal actually drawing one of these marvellous sunsets between six and seven months before there was any eruption of Krakatoa whatever. The italics in the quotation above are Mr. Neison's, not mine. William Noble.

THE DYNAMITE OUTRAGES.

By Richard A. Proctor.

Can a grosser insult to the Irish race be imagined, or an expression of more utter hopelessness, than what "a number of Irishmen" have said in Paris of the dynamite outrages? They represent that "Ireland is fighting in this way for independence," and has "no other means of combatting England." What should we Englishmen feel if we heard that a number of Englishmen in, say, America—even though they might be the offscourings of our gaols—had said of the most cowardly villanies conceivable, perpetrated by persons who chanced to be English, that they were excusable in Englishmen, and indeed that Englishmen had no other means of maintaining their position?

It would be a bad look out for the friends of Ireland if the advance of Ireland depended on the effect produced by these outrages, which are only less contemptible than they are villanous. Once in two or three months certain cowardly hounds succeed in destroying a certain amount of property, and in maiming a few unfortunate persons, all of the poorer classes,—and they imagine, or pretend to imagine, that they are likely to scare Great Britain! Why, every week half-a-dozen persons, chiefly of the poorer classes, are killed by being run over in London alone, and more persons are maimed daily by accidents in London than these wretches succeed in hurting in a year in all England. They may be well assured that no scare is likely to be produced here. I doubt if the timidest old lady has felt a trace of alarm about these dynamite explosions.

The feeling actually produced in the mind of every Briton is akin to that felt when some loathsome crawling creature has stung one and then scuttled off into its foul haunt,—a sense of sheer disgust mixed with the feeling that when next the noxious beast makes one of its contemptible

attacks it must be more promptly pursued and trodden out of existence.

How are we to deal with these pests? I should say offer a reward ten times larger than has yet been proffered, or larger still if need be. When a number of villains have been thus caught and hanged, the informers will very likely be shot or stabbed by others of the gang, and that will be another riddance: their murderers can then be brought to justice and also eliminated. Thus a triple clearance will be effected, and humanity to some degree redeemed from the deep disgrace which the presence of these wretches involves.

For surely this is the deadliest part of the mischief the dynamite villains have done,—to have shown us that the human race is capable of these so much more contemptible villanies than we had supposed possible. The pirates and buccaneers of old seemed to give fearful evidence of what the human race is capable of doing in the way of villany; some kings, rulers, and warrior chiefs have been still more terrible examples of wickedness, having had no such incitements to evil courses; but the villanies of no preceding miscreants were quite so utterly black as those which the dynamiters have attempted. If these villains had a decent amount of courage or even of brains they would not fall so far below the level of pirates and like murderous ruffians as they do. If some among them would come in our midst, boldly bearing the dynamite they mean to explode, and would so disappear in atomic portions, we could even regard them as representatives of an insane sort of patriotism,—merely murderous madmen, not *otherwise* objectionable. Or if, being as unutterably villanous and cowardly as they are, they had a respectable allowance of brains, and laid plots likely to be in some real sense effective, we might think them worthy of a more attentive hatred. But being utter idiots, as well as craven cowards, the atrocity of their murderous designs excites a sickening sense of disgust suggestive rather of the feeling with which the more loathsome types of vermin are viewed than of the horror with which such less contemptible creatures as the cobra and rattlesnake are regarded.

As for the way in which Americans should view and treat the dynamiters in their midst, I would remark that, apart from the weakness of the extradition laws, the dynamiters are in *our* midst too, and we have not yet caught them. We cannot so much blame the Americans for not doing for us what we ourselves are unable to accomplish for ourselves. Yet I think the office of the *Irish World* might be rather peremptorily closed without unduly tyrannous exercise of power. When men openly proclaim that they are collecting money for attempts at murder* and outrage, they should be silenced (nay they cannot be left unsilenced without disgrace)—even though it be perfectly well known that the money so collected is expended on whisky, not on other explosives.

SOME paper-making statistics have recently been compiled on the Continent by some busy figure lover, from which it appears that there are 3,985 paper mills on the face of the earth, in which annually 1,904 million pounds of paper are manufactured. Half of this paper is used for printing; 600 million pounds only for newspapers, the consumption of which has risen by 200 million pounds during the last ten years. As to the use of paper by individuals, an average of 11¼ lb. is used by an Englishman, 10¼ lb. by an American, 8 lb. by a German, 7½ lb. by a Frenchmen, 3½ lb. by an Italian or Austrian, 1½ lb. by a Spaniard, 1 lb. by a Russian, and 2 lb. by a Mexican.—*Engineer.*

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* In the article in which the *Irish World* honoured me by a column of abuse there was enough said in the way of incitement to villany to justify respectable men in insisting that such a paper should be summarily silenced.

Editorial Gossip.

ANOTHER Bank-holiday has brought with it the customary interruption to business, the customary amount of discomfort, and the usual sequels of a disorderly and in large part drunken holiday. To see and hear the returning holiday-makers, on Monday night, on many of the chief roads into London, was to learn what are the fruits of that beneficent system by which the fifty-two holidays really available for the working people are closed (save for the public-houses) and in their place four days have been substituted for the entire year, on which the people are told to make holiday or to go without any. Yet it was said, on rather high authority, once, that the seventh day rest was made for man. Truly our legistative system in this matter is a singular caricature of Christianity.

I HAVE seen the specimens of dress at the Health Exhibition, and noted what the dress reformers want ladies to wear instead of the customary costume. With all respect for the intentions of Mrs. King and Viscountess Harberton, I venture to tell them that they will *never* persuade ladies to follow them; and that it is well they should have no chance of success. The divided skirt, even as they recommend it, is of course something very different from the absurd costume drawn in *Punch*, *Fun*, and other such papers. But it is obtrusive enough to be unwearable by any lady who, respecting herself, desires to pass through our streets without attracting that sort of attention which is offensive and objectionable. In my own circle the divided skirt has been welcomed as lighter, warmer, more comfortable, than the underclothing before used,—and has been adopted (corsets being rejected) for nearly two years. In a quiet sort of way, again, the ladies of my household have converted many to the use of the reformed skirt. Yet no one in drawing-room or ball-room, in the street or on the tennis lawn, could ever guess that any change had been made in the manner in which these ladies dress,—unless perhaps the greater freedom and grace of their movements would suggest that they could not possibly be pinched by corsets or loaded with multitudinous skirts. Thus and thus only, I venture to predict, can any reform be usefully attempted. I myself would not as a rule offer any suggestions to the ladies of my household on such matters, knowing they have sense enough to judge for themselves. But I must confess that if anything would cause me to interfere, it would be the wearing of a form of dress such as the so-called Dress Reformers recommend,—a style which would attract the objectionable notice of every street lout (and many who think themselves respectable people have manners in the street which mark them as street louts).

I FIND that the idea entertained by many that the sign ♎ in my orbit maps should have been ♈, was occasioned by my own mistake in writing ♈ instead of ♎ in the description of the maps. This should be corrected by readers.

FIRE ALARMS IN LONDON.—According to the report of the Metropolitan Board of Works for 1883 just issued, the past year has seen an extension of the system of electric fire-alarm circuits, which are now an important feature in the machinery of the Metropolitan Fire Brigade. There are 23 fire-alarm circuits in operation, the number of points at which an alarm can be given being 151. There are 64 lines of communication by telegraph or telephone between fire-brigade stations, 17 between fire brigade and police stations, and 41 between fire-brigade stations and public or other buildings.

Reviews.

SOME BOOKS ON OUR TABLE.

The Early Days of Christianity. By F. W. FARRAR, D.D., F.R.S. Part I. (London: Cassell & Co.)—This is the first part of a reprint of Archdeacon Farrar's delightful history, and is characterised by all that charm of style and truly catholic spirit which distinguish his writings. In these days of bitter polemics it is a treat to meet with a quasi-theological work in which historical truth is transparently the first object of its author's attainment, and in which no dogmatic exigencies are allowed to operate in a distortion of the facts as they actually occurred.

Fuel and Water. A Manual for Users of Steam and Water. From the German of Franz Schwackhöfer. Edited by WALTER R. BROWNE, M.A. (London: Chas. Griffin & Company.)—Like all German work, this is thoroughly and exhaustively done, and any possessor of a furnace or steam-boiler, who wishes to utilise to the utmost the means at his disposal, can scarcely do better than procure the book whose title heads this notice. What has been, to a considerable extent, heretofore effected in stoking and boiler-feeding by rule of thumb, is reduced by Herr Schwackhöfer to practice, founded upon sound and intelligible theory; and the steam or water user is taught not only exactly what to do, but also why to do it. Highly as we are able to speak of the main portion of the work, we can afford, at least, an equal meed of praise to the introductory chapter on Heat and Combustion, by the Editor. We are not sure that we have yet met with so clear, intelligible, and, in the best sense of the word, popular an account of the mechanical theory of heat, as that contained in this really excellent essay. It might, we think, be reproduced in a separate form; greatly to the advantage of that numerous class of students of elementary physics, to whom mere algebraical formulæ convey but dim and indistinct ideas.

Science Gleanings in many Fields, Studies in Natural History. By JOHN GIBSON. (London: T. Nelson & Sons.)—This charming series of essays appears to be a reprint (with a few additions and emendations) of a series of articles contributed to the *Scotsman* newspaper. It is the very book to put into the hands of young people in whom it is proposed to implant or foster a taste for Natural History. Mr. Gibson writes from the point of view of the evolutionist, and gives the results of the very latest researches in biology. His papers on palæontology are as interesting and readable as are those on recent forms of life; albeit, his conclusions as to the age of pre-historic man in Britain may excite the wrath and indignation of the orthodox. The last glacial epoch in these latitudes may be placed approximately 210,000 years ago, and our author regards man as having been pre-glacial in these Islands!

The Young Collector's Handbook of British Birds—of Shells—of Orders of Insects—of Butterflies—of Beetles—and of Postage Stamps. By various authors. (London: W. Swan Sonnenschein & Co.)—Here is a series of the most marvellous pennyworths that we have ever seen. They are written, one and all, by officials of the British Museum, are well illustrated, and contain just the kind and amount of information required by the beginner, conveyed in a pleasing and easy style. It is not easy to understand how works like these, written by men of eminence in their various departments, can be made a commercial success at the almost nominal price at which they are published. Certainly nothing but the enormous circulation which they well deserve can suffice to render them so.

A Handbook to the Fernery and Aquarium. By J. H. MARTIN and JAS. WESTON. (London: T. Fisher Unwin.)—These are really two separate handbooks, printed on different paper and in different type, but bound in one cover. The author of the Fern moiety of the work makes some funny statements (for example, about the prevalence of the *Osmunda regalis* on p. 25), but his notice of the histology of ferns is not without interest. The second half of the volume is more practical, and will be found useful by those about to start aquaria.

The Weather of 1883, *as Observed in the Neighbourhood of London.* By EDWARD MAWLEY, F.R.Met.S. (London: Ed. Stanford.)—This is a tolerably exhaustive account of the atmospheric conditions prevailing at Addiscombe during the past year. For ourselves, when we glance over table after table of temperature, pressure, humidity, and wind, we are tempted to ask *cui bono?* Perhaps, though, some day a meteorological Newton will arise who will co-ordinate the stupendous existing mass of undigested records and turn them to some account.

The English Language: Its Sources, Growth, and Literature. By THOS. PAGE. (London: Moffatt & Page.)—Here is an early result of the New Code issued by the Education Department. If we admit that it is necessary for the tillers of the soil, and the labouring classes generally, to understand the structure of the language they employ, and to spend their school-time in philological study, then will Mr. Page's book answer its purpose, and, we are bound to say, answer it well. Whether, though, an intimate knowledge of Greek affixes and Saxon suffixes will benefit the class to whom it is proposed to impart it, may form a legitimate subject for discussion. A person may be able to read the time from a chronometer to a fraction of a second, who does not even know what its "escapement" is.

Aids to Botany. By ARMAND SEMPLE. (London: Baillière, Tindall, & Co. 1883.)—Such works as this are the direct and immediate product of the detestable system of cram developed by the examinations of the Science and Art Department. The competitor who wishes to pass in a botanical examination as at present conducted, has nothing to do but to read up Mr. Semple's treatise, to do so with flying colours. As for identifying a buttercup or a foxglove by its aid, though, the incipient student might as well try to master the theorems of pneumatics by watching the weathercock on a church steeple.

Great Industries of Great Britain. Part I. (London: Cassell & Co.).—This is the first part of a serial publication, in which it is proposed to describe the various industries which have made England the foremost manufacturing nation in the world. It contains a chapter on Iron and Steel, by Mr. W. D. Scott Moncrieff; another on Cotton, by Mr. Bremner; one on Shipbuilding; one on Hemp, Flax, and Jute; besides a biography of Sir Thos. Bazley, by Smiles; and essays on Industrial Legislation, and Health and Disease in Industrial Occupations, by Mr. Henderson and Dr. Gordon Hogg respectively. The names of the authors afford sufficient guarantee of the value of their contributions. The illustrations leave nothing to be desired.

The Electrician's Directory, with Handbook for 1884 (London: *The Electrician* Office.)—What it professes to be—a thoroughly complete list of every one engaged in the pursuit of Electrical Science and Art, Theoretical Electricians, Telegraph Engineers, and makers of Electrical Apparatus of every sort and description. In addition to this, there are the fullest details as to the various Electric Light Companies, of the British Cable Fleet, of the Chief Officers of all the Local Authorities in England and Wales, of the

various Railways and their Officials; in fact, the book contains everything that justifies its title.

Tait's Improved Arithmometer. (London: Chas. and Edwin Layton.).—This is a description of an improved and simplified form of the calculating machine originally devised by M. de Colmar, but which has been modified by Mr. Tait. Either addition, subtraction, multiplication, or division may be performed with the arithmometer with unerring accuracy; but the price of the machine is necessarily comparatively high, fifty guineas being asked for one giving sixteen figures in the product. It is, however, easy to understand that in cases in which numerous intricate and repeated calculations are involved such an outlay might prove a really good investment.

THE FACE OF THE SKY.

FROM JUNE 6 TO JUNE 20.

BY F.R.A.S.

THE usual daily examination of the Sun for spots, &c., will be made with the telescope. The night sky is delineated in Map VI. of "The Stars in their Seasons," but twilight now persists all night long. Mercury is still a morning star, attaining his greatest elongation, west of the Sun (23° 3′), at 3 a.m. on the 13th. About this date will be the most favourable time for catching him, somewhat to the north of east, above the horizon, before sunrise. Venus is still, by far, the most conspicuous object in the sky; her crescent continues to diminish as her diameter increases, and she forms at once a beautiful object for the observer with a telescope, and a severe test of the excellence of his instrument. She sets somewhat sooner now, and should therefore be looked at as soon as she is visible—supposing, of course, that the student possesses no means of picking her up in daylight. She is, though, quite visible to the naked eye on a sufficiently clear day, when she crosses the meridian in brilliant sunshine, and, about the time these notes begin, may be picked up in the following way:—She souths on June 7, about a quarter to three o'clock in the afternoon, and about two minutes sooner on each succeeding day. Let the reader then cut a right-angled triangle out of cardboard, whereof we will call the apex A, the left-hand corner B, and the right-hand corner C. The base, B C, must measure 3 in. long, the upright side, A C, 5·8 in., and the slant side, A B, 6·5 in. in length. Then at or about the instant of Venus's meridian passage the base B C must be placed truly horizontal and pointing due north and south, with the end B towards the north and C towards the south. The observer must now place his eye at B, and looking along B A he will, after a little attention, pick up the planet shining in the sunlit sky with a lustre which will astonish him. It must be noted that her meridian altitude, though, decreases slightly daily. At night she casts quite a perceptible shadow of any opaque object interposed in front of a sheet of white paper. The rest of the planets are now beyond the ken of the observer, though possibly Uranus may be picked up, when the twilight has deepened sufficiently, by the aid of the Zodiacal Map on p. 165. No occultations of stars by the moon occur during the period covered by these notes. The moon is in Libra to-day (the 6th), but at six o'clock to-morrow morning she will enter the narrow strip of Scorpio, which forms the northernmost part of that constellation. This she takes twelve hours or so to cross, emerging in Ophiuchus at six in the evening. In Ophiuchus she remains until 3 p.m. on the 9th, when she enters Sagittarius. She takes until 5 a.m. on the 12th to traverse this, and then passes into Capricornus, where she remains until 11 p.m., crossing then into Aquarius. Her passage across Aquarius occupies until 11 p.m. on the 15th, at which hour she crosses the boundary into Pisces, which great constellation she does not quit until 10 p.m. on the 18th to enter Aries. She is in Aries until noon on the 20th, when she enters Taurus. There we leave her.

FRENCH SUBTERRANEAN TELEGRAPHY.—The first proposal for laying down an underground telegraph network for France was made in 1880, by the Minister of War, who at that time asked for a credit of £320,000 for that purpose. The aggregate length of the network is to be 3,435 miles. At present the eastern lines, which are most urgent, are finished, and a good deal of progress has been made with others in the north and north-east. Nearly 2,500 miles are now completed, and it is hoped that by 1886 the whole network will be finished.

"Let Knowledge grow from more to more."—ALFRED TENNYSON.

Only a small proportion of Letters received can possibly be inserted. Correspondents must not be offended, therefore, should their letters not appear.

All Editorial communications should be addressed to the EDITOR OF KNOWLEDGE; *all Business communications to the* PUBLISHERS, *at the Office, 74, Great Queen-street, W.C.* IF THIS IS NOT ATTENDED TO DELAYS ARISE FOR WHICH THE EDITOR IS NOT RESPONSIBLE.

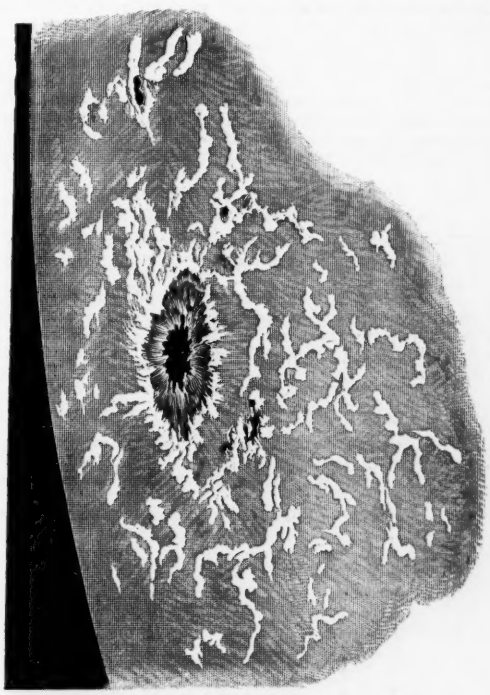
All Remittances, Cheques, and Post Office Orders should be made payable to MESSRS. WYMAN & SONS.

The Editor is not responsible for the opinions of correspondents.

NO COMMUNICATIONS ARE ANSWERED BY POST, EVEN THOUGH STAMPED AND DIRECTED ENVELOPE BE ENCLOSED.

SUN-SPOT.

[1284]—As the sun's disc is at present showing some large and interesting spots, it may please the readers of KNOWLEDGE to see the fine wreaths of faculæ that surrounded the large spot that has just disappeared round the rim. I have enclosed a careful copy



May 20, 8.30 a.m. 3½ in. Wray, power 120.
Drawn from the screen.

from my drawings. The spot as seen on the 15th was really a striking object, with its many tongues running into the dark umbra, which had on the left part of it a thin veil of faculæ that stretched across it, giving the dark part the effect of greater depth.

E. L. BROWN.

"TWINKLE, TWINKLE."

[1285]—I trust to the proverbial justice and courtesy with which your name is inseparably connected [Oh, sir.—R.P.] to find space for the following:—1. If G. G. H. will take the trouble to refer to "Rhymes for the Nursery" (not "Original Poems for Infant Minds"), by Ann and Jane Taylor (which he can see at the British Museum, or, failing this, procure for a comparatively

trifling sum, of T. Nelson & Sons, Paternoster-row, London, E.C.), and turn to page sixteen of the same, he will there find the poem, the authority of which he disputes. 2. Nothing bearing the *faintest* resemblance to the poem in question appears in the "Ryght Pithy Pleasaunt and Merie Comedie intytuled Gammer Gurton's Neele." (See Dodsley's "A Select Collection of Old Plays," Vol. II.) Dr. Drury, as a "Dr.," should have known better. (*Vide* KNOWLEDGE, No. 132.)

The question is, why did not G. G. H. consult the play itself, rather than take the authority of Dr. Drury? And (3) G. G. H. refers me to "Notes and Queries," for "the original Latin version." I said nothing about this. Why did he not rather turn to page 45, of the same volume, which he erroneously quotes from (for he writes* "*Mira, Mira*," for "*Mica, Mica*") where the following 'note' (I quote a part of it) is given:—"Twinkle, Twinkle, Little Star! Done into Latin by Spirits. . . . Several Latin quotations were given; among the rest the following translation of a stanza from *Jane* [and Ann, of course] *Taylor's* little nursery poem, beginning "Twinkle, twinkle, little star," &c. And now for *hic finis fandis*, so far as I am concerned, at any rate, for I have neither the time nor the inclination to haggle over the authorship of a poem never before disputed. I beg to thank the Editor of KNOWLEDGE for his forbearance in allowing the discussion to go thus far, to, I should honestly think, the satisfaction of all parties. *Valete ac plaudite? Heu!* J. W. HOWELL.

DUALITY OF THE BRAIN.

[1826]—I had been dreaming one morning of a scene in a drawing-room in which the figure of one of my friends stood clearly out, and awaking in the daylight, I saw distinctly, at the same moment, the figure of my friend as with one eye and the top of the bed with the other! I awoke in a state of considerable excitement, thinking what a strange thing that one eye should be asleep and the other awake at the same time! Will not the fact that one eyelid happened to open before the other, and your correspondent, Leonard H. Rudd's suggestion (KNOWLEDGE, p. 250) respecting the duality of the brain, help to explain this circumstance, whilst the circumstance itself tends to confirm the view expressed in the foot-note. R.

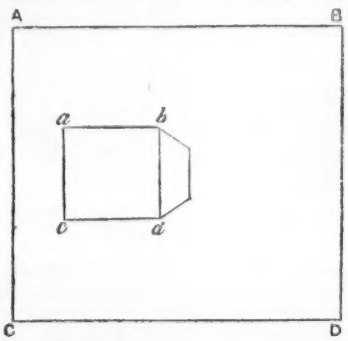
PRESERVING INSECTS.

[1287]—I should be glad if one of your correspondents would kindly inform me what is the best way of preserving insects for *future* microscopic use.

If pressed and dried, they become so brittle that they will not bear handling, while they are out of all shape. If placed in fluid, how will this leave the wings of moths and butterflies? I ask, having friends in the Tropics who would send me things if I would tell them how. S. BOYD.

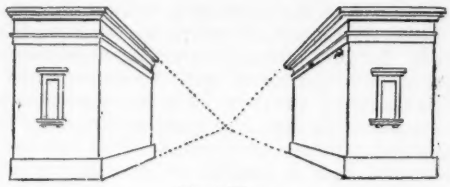
IMAGINARY FALSE PERSPECTIVE.

[1288]—With reference to the difficulty felt by your correspondent R. Jones, regarding perspective (KNOWLEDGE, May 16, p. 358), I submit] the following illustration of the theory which is usually

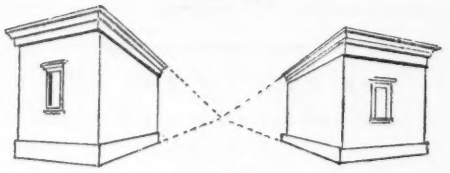


acted on. Imagine a plate of glass A B C D to be the plane of a picture. Imagine a log of wood with a square end, to be placed behind it, and at right angles to it, and with the square end butting against the glass as if about to crush it. Then I say that if the outline of this square end A B C D be traced with a diamond on the glass, it will equally be square whether the log of wood be at one side or in the middle of the glass; the sides of the square end will not converge as your correspondent thinks, though the log of wood be so much on one side of the centre that the length of the log may be seen in perspective behind the middle of the glass.

AN OLD DRAUGHTSMAN.



Usual Way.



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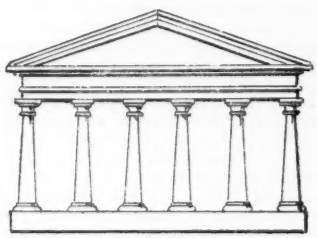

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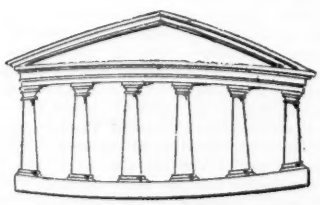


Unusual Way. N.B.—Something like this might be called for, if the plane of the picture were a curved surface, as in a Panorama.

[Very neat. Here is a question for consideration. In the usual way of picturing the axes in co-ordinate geometry of these dimensions the axes of x and y are at right angles. Is this right?—R. P.]

A STRANGE COINCIDENCE.

[1289]—An American lady—Mrs. B.—on seeing the article headed thus in KNOWLEDGE, of May 16 (No. 1,237), told me of a singular incident which happened to herself a few years ago.

Her mother, living in New Jersey, had suddenly become an invalid from a slight stroke of paralysis. She and her sister were called to the spot, and when examining the contents of some old boxes in a lumber-room, they came upon a packet of old letters, amongst which was one which had been written to their deceased father thirty years before, by his old friend M. J. S., whose home was in the West, a long distance off. The two younger ladies took the letters down to their mother in order to ask whether she wished them destroyed. Just as their mother was occupied in reading this particular one, a knock was heard at the house door, and M. J. S., the very man who had written this letter, was ushered into the appartment, a totally unexpected visitor. COSMOPOLITAN.

COINCIDENCE WITH CAWS.

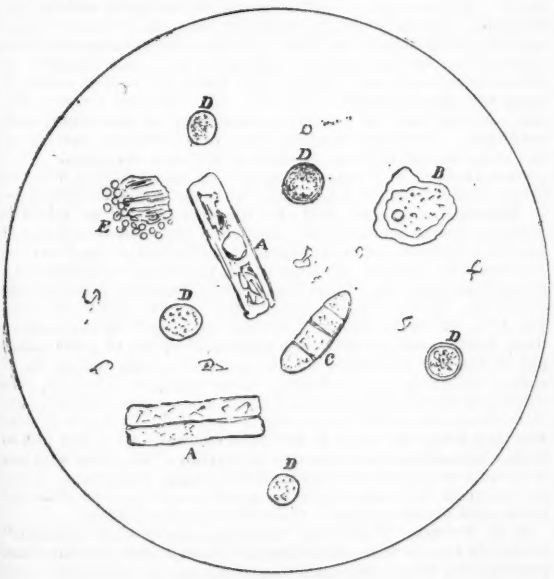
[1290]—On Sunday afternoon, March 13, 1881, about 3.30, p.m., I was taking a quiet stroll on the lawn in front of my house, having my after-dinner smoke, when suddenly two rooks appeared upon the scene. They circled about over my head, within easy gunshot,

* He wrote the words rightly; they were mis-printed.—ED.

at the same time uttering all the while their discordant "caws." So persistent were they that I involuntary looked up, exclaiming, "What ill omen do you black rascals bode." Now, it was not the fact of the rooks being where they were which arrested my attention, as there is a large rookery close by, and the birds daily visit these grounds. It was their persistent "Caw, caw!" and the birds themselves wheeling in circles not twenty yards above my head. At that moment the late Emperor Alexander was assassinated in the streets of St. Petersburg. YOHAMITA.

ORGANISMS IN HAILSTONES.

[1291]—I have seen occasionally some reference made to the fact that snowflakes and hailstones when examined under the microscope, were found to contain organised forms, but I doubt if it is known that they are met with to such an extent as I have lately noticed. I have on two or three occasions during the last twelvemonth collected a few hailstones in a conical glass, so that anything contained in them subsided to the bottom as they melted, and have always found organised remains, but I never had any idea of the quantity of these till the hailstorm of the 5th inst., and I now send drawing of the contents of a single hailstone (about ¼ in. diam.) which I placed with every precaution as to cleanliness, between the glasses of a live box. The figures are carefully drawn in proportion to each other on the understanding that the bodies marked D were of about three or four times the diameter of a human red blood corpuscle. The only respect in which the drawing does not truly represent the exact contents of the hailstone is that there were, at least, forty of the spheres D, which appear to me very like ova of some of the oviparous Rotiferæ. The amœba and one diatom were in active movement. The spore (?), C, I would call the attention of some of your microscopists to, and should be glad to hear if they are acquainted with it, as it is one of several of the same kind which I discovered among the fibres of the heart of animals dead from cattle disease in India, in 1870, and described in the monthly *Microscopical Journal* for December of that year, p. 312. B. M., F.R.C.S.



CONTENTS OF SINGLE HAILSTONE.

A. Diatoms—one of them in active motion.
B. Living amœba.
C. Spore (probably of fungus), olive brown.
D. Pale yellowish bodies, like ova in size, about three to four times diameter of human red blood corpuscle.
E. Dark brown mass, with small bright spherules

THE ORIGIN OF THE WORD "CAUCUS."

[1292]—Mr. Bulley's query as to the origin of the above is thus explained by "The Oracle" of Feb. 24, 1883:—"Caucus is a word of American origin. The oldest use of the word is often supposed to be in the following passage in John Adams's diary, dated Boston, February, 1763:—'This day learnt that the Caucus Club meets at certain times in the garret of Tom Dawes, the adjutant of the Boston regiment. He has a large house, and he has a moveable (*sic*, J. W. H.) partition in his garret, which he takes down, and the whole club meets in one room. . . . . There they choose a moderator, who puts questions to the vote regularly, and select men, overseers, collectors, wardens, fire-wards, and representatives are regularly chosen by the town. They send committees to wait upon the merchants' club, and to propose and join in the choice of men and measures. Gordon, in his "History of the American Revolution," traces this practice to even an earlier date. It has been conjectured that caucus is a corruption of calkers. Very possibly the Caucus Club which met in Tom Dawes's garret was originally a mechanics' club, called from the leading trade in it the Calkers' Club, which name, with a variation, is still retained after it passed into the hands of politicians. Mr. J. H. Trumbull derives the term from an aboriginal word, meaning to speak, encourage, instigate. The singular of the Indian noun is said to have been kaw-kaw-was, plural kaw-wus-sough, "councillors, which the Virginians changed into cockarouse, designating a pretty chieftain; and it has been supposed that thence come caucusers, and caucus." It would, I venture to think, be interesting to know what Dr. J. A. H. Murray, the President of the Philological Society, and editor of the new English Dictionary, has to say about the etymology of the word under consideration.

J. W. HOWELL.

THE MYSTERY OF GRAVITY.

[1293]—If Mr. Aynsley [Letter 1239] will reconsider the question, I think he will be led to change his opinion regarding the source of the energy derived from falling water.

If we consider the case of a cork constrained to remain beneath the surface of a liquid, it is obvious that in transferring it to that position, *the water which it displaces* has been raised through a certain distance *against the force of gravity*, and, therefore, possesses potential energy. If now the cork be liberated, the water is free to fall, and its potential energy becomes kinetic, part of which is consumed in raising the cork to the surface again. Now, the source of energy here can no more be traced to gravity than can the source of energy in a catapult be traced to the elastic of which it is made. When the catapult is drawn, energy is stored up by doing work against the elastic, which becomes kinetic when the missile is released. The elastic does work it is true, but only by virtue of work done upon it previously. So, in the case of the cork, gravity does work in drawing down the water, and so raising the cork; but only by virtue of work done against it previously in raising that water, which work must have been derived from some other source.

Now, to turn to the main point, which is much more complicated. In raising water, the sun does two kinds of work. Firstly, *internal work*, which is expended in raising the temperature and changing the state of the liquid. But secondly it does *external work* against gravity, by lifting that portion of the atmosphere which is displaced consequent on the increase in the volume of the water on passing from the liquid to the vapour state. Thus we may suppose that *for an instant* this raised portion of the atmosphere has potential energy, which is immediately converted into kinetic energy as it falls, and part of this is consumed in raising the aqueous vapour. Now, if this vapour, from any cause whatever, should at any time return to the liquid state, it will again reach the level of the sea in virtue of that energy which was stored up when it was raised, and may be made to do work in its fall, which work is clearly done indirectly by the sun, and has not the force of gravity as its ultimate source.

Mr. Aynsley says:—"Nor is there any connection or commensurability between the energy of falling water on the earth and that energy of the sun which had previously vapourised it." The cause is not far to seek. The energy which is consumed in actually raising the aqueous vapour bears no comparison to that consumed in changing its state, and the greater part, if not all, of this *internal work* is again converted into heat upon condensation. C. P.

THE PATENT ACT.

[1294]—I am pleased to see that you are treating of such a widely interesting subject in KNOWLEDGE as the "New Patent Act," and as it is of practical interest to me, I would like to ask a question or two on the subject, which, perhaps, the writer of the article will kindly answer. The following are the questions:—

1. After a *Provisional Specification* has been sent in with a full set of drawings, is it necessary, in case there be no alteration in them, to send in a duplicate of the drawings with the *Complete Specification?* Will not the one set of drawings which has

been sent with the Provisional be sufficient for the Complete Specification?

2. In the case of taking out two patents for inventions which are somewhat allied, and which might be used in conjunction with each other, will the sketch required for the *Illustrated Journal* be sufficient if it illustrate the two inventions combined, provided the two complete specifications are sent to the Patent Office together?

FRANK WEST.

PROPERTY OF NUMBERS.

[1295]—The following, which is due, I believe, to Bishop Cotterill, is a neat problem, and may exercise the ingenuity of your readers:—

"Given the remainder when a number of three digits is divided respectively by 3, 5, 7, 11, to find the number."

It would also be interesting to trace the modifications of the solution if we introduce another divisor, as for instance 13.

C. W. BOURNE.

SQUINTING.

[1296]—The remarks lately made by Mr. W. Cave Thomas on the subject of vision by means of an instrument called the diascope, intended to present to the right eye the view ordinarily falling to the left and *vice versa*, encourages me to ask space for one or two notes on a kindred subject—namely, squinting. This power, which can be easily acquired, but must be cautiously practised to avoid injury to the eyes, is, I think, of some psychological interest.

I note then, first, that the difference of colour tint in the fields of the two eyes, referred to by Mr. Thomas, though sometimes very marked, is not permanent. The natural delicacy of the organ would lead us to expect some difference. It could hardly be otherwise, seeing that the eye is so readily dazed by lights, and has its vision after staring at a colour so soon tinted with the complementary. Is this last, by the way, anything more than an application of the law of relativity, which renders us deaf to a continuous and continued sound, and makes the one hand, coming from cold water, feel lukewarm water hot, while the other from hot water feels it cold?

It is to be noted, also, that the focus of the eyes, usually coinciding with the point whither their vision converges, can readily, with a little practice, be made adjustable to any object towards which we squint, however near the point of convergence is to the face, and that the two eyes may be focused differently.

If a stereoscopic slide is cut in two, and the parts interchanged, the apparent relief of the objects, as is well known, can be seen by squinting quite as readily as with the stereoscope. Four pictures in all are seen by the two eyes, and it is only necessary to make the middle two overlap and coincide. This fact shows the correctness of the above remarks, and likewise brings out one or two interesting facts. Why does the slide appear smaller when so treated? This effect is marked and even startling. It is, I think, an optical delusion, depending on the fact that the eyes, converging to a point nearer the face, unconsciously conclude that the object is there, and at that distance expect it, of course, to present a larger appearance. Hence the convergence of the eyes must have more effect in determining the distance of an object than the adjustment of the focus has. An object more and more squinted at diminishes in size if retained in focus the while.

Even if the slide is not cut, the eye still interprets the appearances as indicating relief, and does not usually make the concaves convex, and *vice versâ*, though one would expect this. Accordingly, it must be inferred that almost any slight difference in the pictures of the two eyes will, within limits, be taken as an evidence of solidity, *provided that the nature of the object under inspection is such as to lead us to expect it to be in relief.* The two stereoscopic photos, however, do not combine *equally* well when the photo on the right is seen by left eye and *vice-versa*. When the relief is very great, the eye becomes confused and at a loss. This will be seen by examining the slide with the stereoscope after cutting it and arranging it as above. If the relief is very great the eye then becomes confused and at a loss. A slight difference in two pictures does not prevent coincidence in the view; it is well known that under the stereoscope a circle may be made to combine with an ellipse of small eccentricity and equivalent size. In the case of very simple figures, as a sphere, an interchange of concavity and convexity may occur.

It is possible, with a number of similar objects possessing cubical dimensions (say a row of hat-pegs), to make the picture of one peg in the right eye overlap another in the left. Thereupon the solidity of the peg, is exaggerated—they appear longer. A peg to the left hand is brought by the right eye more to the front, and the left eye brings one in the opposite direction to meet it. These being seen more sideways than a front peg would be are less foreshortened; hence, when they come to the front they appear longer.

I have never been able to effect a super-imposition by converging the eyes to a point behind the row of pegs. I believe it, nevertheless, to be practicable. For if we hold, say, three equal pencils at equal distances in the hands before the face, and gaze between them at a point in the opposite wall, we shall at length, by varying their distance, cause their duplicates to coincide. I have never thus succeeded in securing a focus. Has any reader effected it?

P. J. BEVERIDGE.

LETTERS RECEIVED.

T. COMMON. You are, of course, right; your meaning was sufficiently clear.—J. C. E. Thanks. Yet what a capital name Zetetic is for a medicine, such a one as "searcheth" the reins and the liver, for example.—A. B. C. The idea is rather of elliptical motion in a plane at right angles to the direction of transmission. But the whole subject is crowded with difficulties. The properties of the æther of space are contradictory—infinite elasticity and infinite rigidity.—C. P. Letter in hand.—EXCELSIOR. Many thanks. I had overlooked that mistake, which I will at once correct. There is, however, no reason for putting ♈ instead of ♓ as the spring sign in a heliocentric chart. Your later letter received. The misunderstanding is removed, is it not?—J. T. ROUTLEDGE. I am away from my books, and unable to point to a passage. I fancy every believer in evolution — which is nearly the same thing as saying every man of science—believes that at some time in the history of the earth there was spontaneous generation; but science knows nothing experimentally of any kind of life other than that which has sprung from former life.—E. L. G. Your interesting letter on Noah's Rainbow in hand; may be delayed, though, on account of length.—H. SNAIBURN. That would hardly suffice to explain why satellite looks sometimes as dark as its own shadow.—R. J. S. Neither am I a "betting man." Multiplying is right. Each event of one set may be combined with each event of the other set, giving product of the two numbers as total number of pairs of events.—E. Your interesting letter would unfortunately be misunderstood by many. (I know this from experience). As you say, a deaf-mute would not give satisfactory evidence. Nor would a man brought up with full scientific knowledge but without religious ideas. Perhaps the strongest evidence is given by men of science who have *not* been brought up without religious ideas. But we must leave the subject alone, or many will misunderstand.—A. J. W. Your telescope seems a fair one. Nebulæ vary in appearance according to the atmospheric conditions. Pictures such as we draw of Jupiter say nothing as to power, because they can be held at different distances. Have you tried looking with one eye through telescope at Jupiter, with the other—unaided—at the moon, when she is pretty near the planet?—J. BINDON CARTER. Ah, well; for the sake of logic we might as well keep to the assumptions. Assuming otherwise you arrive at another inference—(alliteration artful aid affordeth).—JOS. CLAYTON. In the earlier numbers of KNOWLEDGE, papers on "Nights with a 3-inch Telescope—the construction of an astronomical telescope was described. Have not back numbers with me.—W. LEWIS. Perhaps Mr. Allen will write about that matter. You say "we have taken a lively interest and am still very sceptical,"—joker of jokes might ask if you are something beside yourself: every editor is, of course,—officially.—J. M. BROWN. Have sent your letter to publishers; if there is delay the fault is not ours. *You* evidently consider we are something beside ourselves.—O. B. That sort of rainbow ring round the moon is not very unusual. Glad you find so large a proportion of our contents interesting. We agree with you it would be a pity to pad with trash and charge fourpence. Know no reason for supposing our solar system more ancient than any other parts of the universe. Quite the contrary, I think.

E. W. PREVOST. There is no "advantageous form of generator" to supply two or three incandescent lamps, unless for occasional experiments, when large-sized Grove Bunsen or bichromate cells answer best. The number of cells needed depends upon the electromotive force required. Almost an equal number of "storage batteries" would be required, their E M F being very little higher than that of a good primary cell. Consequently they are not to be recommended.—H. D. W. The object in view in writing the earlier portion of the article referred to was to demonstrate the inefficiency of batteries for electric lighting. The fall of free potential, consequent on the insertion of low resistances, was neglected to simplify matters. A recognition of the fact would only have intensified the argument set forth. The difference in the case of the incandescent lamp is immaterial, although it is admitted that it would have been better to employ larger cells (of lower resistance), in order to render the depreciation of the free potential negligible. The question shall, however, be further dealt with.—T. H. CHRISTY.

XUM

The local features which determine a lightning discharge are so various, and the subject has received such a small amount of attention, that it would be unsafe to assign a cause for the varied effect upon the wire forwarded. We have seen many remarkable effects, each doubtless the consequence of a specific cause. Nevertheless, many of these causes are undiscovered.

Our Mathematical Column.

EASY LESSONS IN CO-ORDINATE GEOMETRY.

By Richard A. Proctor.

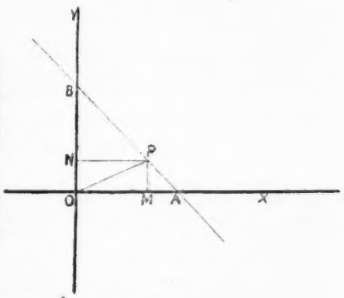
(*Continued from p.* 381.)

We proceed to discuss some other convenient forms of the equation to a straight line.

32. *Def.* The two lines intercepted between the points in which a straight line meets the axes of x and y, and the origin are called respectively, the *intercepts* on the axes of x and y and are considered positive or negative according as they are measured from O in the positive or negative direction along either axis.

Thus in the figure to Art. 31, O A is the intercept of the line A B on the axis of x and is negative, O C is the intercept of A B on the axis of y and is positive.

33. *To find the equation to a straight line in terms of the intercepts on the axes.*



Let A B be a straight line meeting O X and O Y in the points A and B respectively; and suppose $OA=a$ and $OB=b$. From any point P in A B draw the ordinates P M and P N, and join O P. Let the co-ordinates of P be x, y.

Then $$2\triangle APO+2\triangle BPO=2\triangle BOA$$

that is $$bx+ay=ab$$

the required equation.

Dividing by ab the equation assumes the convenient form

$$\frac{x}{a}+\frac{y}{b}=1. \qquad \text{(ii.)}$$

in which it is generally employed.

34. Conversely any equation of the form (ii.) is the equation to a straight line. For multiplying by $\frac{1}{2}ab$ it becomes

$$\tfrac{1}{2}bx+\tfrac{1}{2}ay=\tfrac{1}{2}ab$$

which shews that if we take $OA=a$ and $OB=b$, and join any point P on the locus of the equation with the points B, O, and A as in the figure, the sum of the triangles O P B and O P A is equal to the triangle included between the lines O A, O B, and A B, which it would obviously not be if P did not fall on A B. Hence the locus of the equation is the straight line A B.

35. To show that the general equation of the first degree

$$Ax+By+C=0 \qquad \text{(i.)}$$

represents a straight line.

Dividing by C (i.) becomes

$$\frac{Ax}{C}+\frac{By}{C}+1=0$$

which may be written

$$\frac{x}{-\frac{C}{A}}+\frac{y}{-\frac{C}{B}}=1;$$

hence by 34 it is the equation to a straight line whose intercepts on the axes of x and y are $-\frac{C}{A}$ and $\frac{C}{B}$ respectively.

36. If A=0, the intercept on the axis of x becomes infinite, and the straight line is therefore parallel to the axis of x. This is also obvious from (i.) which in that case becomes

$$By+C=0, \text{ that is } y=-\frac{C}{B}$$

and this by Art. 30 represents a straight line parallel to the axis of x, and whose intercept on the axis of $y=-\frac{C}{B}$.

37. Similarly, if B=0 (i.) represents a straight line parallel to the axis of y, and whose intercept on the axis of $x=-\frac{C}{A}$.

38. If C=0 the equation (i.) becomes

$$Ax+By=0 \qquad \text{(2)}$$

that is

$$\frac{y}{x}=-\frac{A}{B}$$

which by Art. 30 represents a straight line through the origin inclined to the axis of x at an angle whose tangent $=-\frac{A}{B}$.

39. We can also show that the last-named angle is the angle which the straight line represented by (i.) makes with the axis of x whether C vanish or not. For if α is the angle that any straight line makes with O X estimated in the manner described in 31, then

$$\tan\alpha=-\frac{\frac{C}{B}}{\frac{C}{A}} \text{ in the case of the line represented by (i.).}$$

Lastly,* if C=0, and also A or B=0, the equation (i.) becomes $y=0$, or $x=0$ respectively; that is the equation represents O X or O Y respectively.

(*To be continued.*)

EASY RIDERS ON EUCLID'S FIRST BOOK,

With Suggestions.

Prop. 32 (*continued*).

109. Show that the interior angle of a regular figure of n sides exceeds a right-angle by $\frac{n-4}{n}$ths of a right-angle.

110. On the sides of any triangle A B C equilateral triangles B C D, C A E, A B F are described, all external to A B C. Show that the lines A D, B E, C F are all equal.

Establish the equality of the triangles A C D, B C E, *&c.*

111. In the triangle A B C, the lines B D, C E are drawn perpendicular to AC, A B, respectively. Show that the angle A B D is equal to angle A C E.

112. With the same construction show that the angle E F D exceeds the angle E A D by twice the angle A B D.

113. Show, also, that the angle D F C is equal to the angle B A C.

114. Show, also, that the angles B F C, B A C are together equal to two right angles.

115. If the straight lines bisecting the angles at the base of an isosceles triangle be produced to meet, they will contain an angle equal to an exterior angle of the triangle.

116. Show that every right angle may be divided into two isosceles triangles.

117. If A B C be a straight line, bisected in B, and any line B D equal to A B, or B C be drawn from B, show that A D C is a right angled triangle.

118. Trisect a right angle.

119. Construct an isosceles triangle, having the vertical angle equal to four times the angle at the base.

120. One of the acute angles of a right angled triangle is three times as great as the other; trisect the smaller of these.

121. On a given straight line A B an equilateral triangle A C B is described, the angles A and B are bisected by lines meeting in D, and lines D E, D F are drawn parallel to the lines A C and B C respectively. Show that the line A B is trisected in the points E and F.

(*To be continued.*)

* If A=0, and B=0, C remaining finite, equation (i.) assumes the form C=0, a form apparently expressing an absurdity. In reality, however, the equation in this form admits of interpretation; for if, instead of being made equal to 0, A and B were made to become indefinitely small in actual value, we see that $-\frac{C}{B}$, and $-\frac{C}{A}$, that is the intercepts on the axes, become indefinitely great, and $\left(-\frac{C}{B}\right)\div\left(-\frac{C}{A}\right)$ assumes the indefinite form $\frac{\infty}{\infty}$; hence C=0 may be assumed to represent a line at an infinite distance from the origin and indefinite in direction.

Our Chess Column.

By MEPHISTO.

SOLUTION OF PROBLEM, p. 381.

1. Q takes P on Q5 (ch.) The Queen can now be taken by seven pieces, each capture giving a separate mate, *i.e.*,

1. K takes Q	2. R to QR4 mate
1. P takes Q	2. R to K6 mate
1. B takes Q	2. B takes R mate
1. R takes Q	2. R takes B mate
1. Q takes Q	2. B to Kt2 mate
1. Kt(Kt3) takes Q	2. Kt to B5 mate
1. Kt(Kt5) takes Q	2. Kt to Q6 mate

A most beautifully constructed problem, and difficult, in spite of the first move being a check.

POSITION IN A GAME PLAYED IN THE DIVAN TOURNAMENT.

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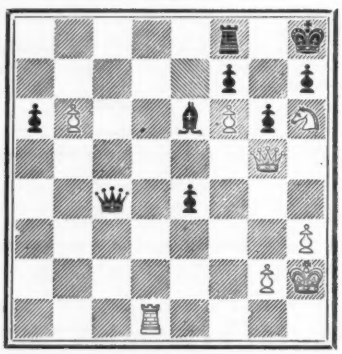

WHITE.

White wins by

Kt takes P	B takes Kt	or	K to Kt sq
Q to R6	R to Kt sq	Q to R6	K takes Kt
R to Q8	B to K sq	Q to R7(ch)	K to K sq
R takes B	Q to KB2	Q to K7 mate	
R to K7 and wins			

The following extraordinary ending was sent to us by a correspondent, and is supposed to have occurred in actual play. It certainly looks more like a very difficult problem how to mate in five moves :—

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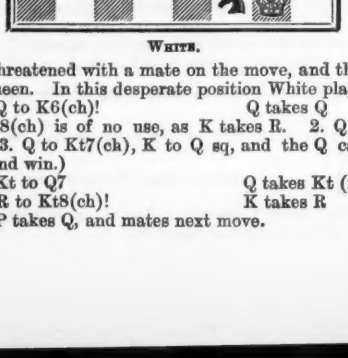

WHITE.

White is threatened with a mate on the move, and the P on K7 can go to Queen. In this desperate position White played :—

1. Q to K6(ch)! Q takes Q

(1. R to Kt8(ch) is of no use, as K takes R. 2. Q to Kt4(ch), K to B sq. 3. Q to Kt7(ch), K to Q sq, and the Q can interpose next move and win.)

2. Kt to Q7 Q takes Kt (forced)
3. R to Kt8(ch)! K takes R
4. P takes Q, and mates next move.

PROBLEM (SELECTED.)

By W. GRIMSHAW.

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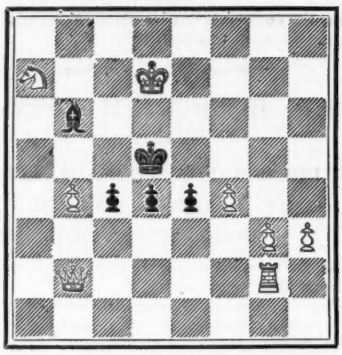

WHITE.

White to play and mate in three moves.

ANSWERS TO CORRESPONDENTS.

*** *Please address Chess Editor.*

W. Hamahan.—We should be much obliged if you would kindly send us a copy of the Problem published in the "Irish Fireside" of April 7.

H. M. W.—Solutions are published a fortnight after publication of Problem. Correct solutions received of H. M. W., S. Osborne.

W. Hamahan, Donna.—Solutions incorrect.

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